Greenhouse gas emissions in Winchester District: Part XI

Estimates, trends (2005-2019) and future mitigation

Bob Whitmarsh and Robin Speed

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Main Campus, University of Winchester, Winchester SO22 4NR
01962 827083 contactus@winacc.org.uk www.winacc.org.uk
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Purpose of this report

Winchester Action on Climate Change wants to help policymakers, citizens and businesses make decisions about what they need to do to tackle the climate emergency – an emergency that events in 2021 show is fast becoming a crisis not only for humans but also for much of life on Earth.

This report was written to offer advice to Winchester City Council (WCC) on how they could achieve net zero carbon emissions across Winchester District by 2030 following their declaration of a Climate Emergency in June 2019.

The report aims to show the emissions from different sources, their variations since 2005, and where we might be heading. We also give our recommendations for actions that Winchester City Council can take towards its target of carbon neutrality across Winchester District by 2030.

The report inevitably includes a lot of data as tables and graphs. We hope that we have also managed to describe the main sectors in which emissions can be cut. Data sources quoted in the text are listed in the Bibliography section.

The report is the eleventh of a series of annual reports which draw together data about greenhouse gas emissions in Winchester District, based on UK Government data published by the Department for Business, Energy and Industrial Strategy (BEIS). All the reports were prepared by Winchester Action on Climate Change (WinACC). The authors acknowledge the advice and suggestions of many people from WinACC, especially Brian Shorter of WinACC's the Science and Technology Advisory Panel, and members of the WinACC group on working with the Council, especially when everything had to be done virtually because of the pandemic.

Some important points to be aware of when reading this document:

1. Because this report is based mostly on BEIS data up to 2019, the most recent available, it doesn't describe the situation in September 2021 when this report is published.
2. All this data comes from before COVID-19. There is no impact from lockdown in the emissions reported here.
3. We cannot tell if the drop in total energy use after the upwards trend between 2013 and 2018 is an encouraging change or just a one-year blip. To be confident that a change is real, we need to see it continue for two or three years.
4. Where we give percentages of emissions from various sources (transport, heating etc), this is the percentage of all emissions before deducting the "negative emissions" carbon capture impact of land use.
5. Because this report is focused on reducing the emissions of the district we only mention renewable energy in passing, although we acknowledge its importance. Renewable energy needs to be addressed separately in a Green Energy plan.
6. We are aware that a lot of work is already under way or being planned. Our recommendations do not distinguish between actions that are already being taken by the City Council or others and new actions, because we want to help with setting priorities across all possible actions.

Executive summary

Data published by the Department for Business, Energy and Industrial Strategy (BEIS) indicates that the estimated annual direct emissions of carbon dioxide (CO_2) from Winchester District in 2019 were 782 kilotonnes of CO_2 ($ktCO_2$). This is a 31% reduction from the comparable 2005 figure of 1134 $ktCO_2$. Most of this reduction is due to the reduction in emissions from the generation of electricity; the remaining non-electricity-related emissions fell by about 17% from 795 $ktCO_2$ to 659 $ktCO_2$ over the same period.

Most of these CO_2 emissions come directly from our energy use and are calculated from estimates or meter readings of the energy used in the district. Total energy use in Winchester District decreased from 2005 until 2013, then slowly increased up to 2018, and then fell sharply in 2019, according to data from BEIS. 2019 also saw falls in the district's consumption of car fuels and in commercial electricity and gas.

Almost half the Winchester District energy use reported by BEIS is attributable to road transport. Although there has been considerable variation in energy consumption among different types of road vehicles (petrol cars v. diesel cars and a huge growth in diesel vans) the total energy consumed by road transport in the district has remained almost static.

The remainder of the district's energy use is attributed by BEIS to the use of electricity, gas and residual fuels.

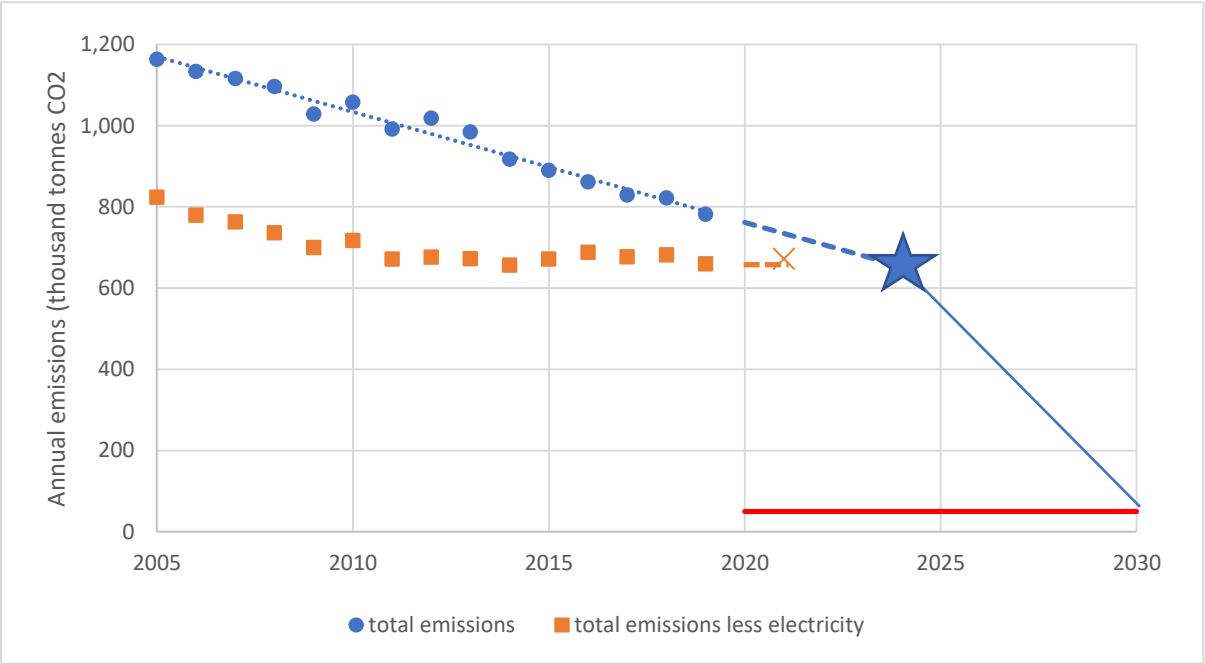
The plot of Winchester District emissions between 2005 and 2019 in the figure below starkly illustrates how little non-electricity emissions have decreased in the past and how much emissions must fall if the district is to become carbon neutral by 2030. The district's total direct emissions have fallen steadily since 2012 (dotted blue line in figure) largely because of the progressive closure of the UK's coal and oil burning power stations. This will cease in late 2024. If no other savings are made in the district, the estimated total emissions in 2024 are shown by the blue star.

Omitting electricity, the total emissions from other sources in the district have barely changed since 2011 (orange squares in figure) and the estimated emissions at the end of 2021 are shown by the orange cross.

The solid blue line indicates that on average a reduction of 104 kt CO_2/year will be required to reach net zero emissions by 2030, assuming that non-electricity and land use, land use change and forestry (LULUCF) emissions remain essentially unchanged up to 2024.

Looking at the changes in emissions in detail we see reductions from motorway traffic, some public buildings and domestic residual fuels (mostly heating oil and coal) and increases in non-domestic residual fuels.

In 2019, road transport, including motorway emissions, was responsible for 58% of the district's emissions, followed by domestic gas (14%), and non-domestic electricity (9.6%). Land use of all sorts is a useful net sink of carbon (-6.3%).



The total direct annual emissions of Winchester District from 2005 up to 2019 on a timescale that ends at 2030 when the City Council intends the district to be carbon neutral. The dots denote total emissions which have been steadily decreasing largely because of the systematic closure of UK fossil-fuel-burning, and especially coal-burning, power stations since 2005. The squares show a more realistic appraisal, which excludes the emissions from electricity consumption, and suggests that the district's emissions reached a plateau, or at least were no longer declining, around 2014. Net LULUCF emissions, which are currently negative, will offset the target (red line) yielding net zero in 2030.

Another data set, which provides information at parish and ward level, shows that emissions are spread unevenly throughout Winchester District. 71% of household emissions are sourced outside Winchester city from just 64% of the district's population. A quarter of all BEIS industry and commercial emissions come from just two rural business parks.

Maps of the National Atmospheric Emissions Inventory show that emissions appear to be concentrated around main roads and populated areas reflecting the burning of fossil fuels by road vehicles and home central heating systems (mains gas, oil and LPG), respectively.

Suggestions for future actions are hampered by a lack of detailed information on energy consumption and emissions from the industry (principally manufacturing), commercial and public sectors which are responsible for 21% of emissions. Nevertheless, we identify areas in which Winchester City Council could act to reduce the district's emissions. Not surprisingly these include road transport, homes, non-domestic buildings and business and industry. We appreciate that the City Council has limited powers e.g. planning, and so many of our suggested actions depend on influencing others. We also stress the importance of appropriate financial planning to create extra funds.

Renewable energy generation should be supported by the Council as part of its contribution to meeting UK emissions targets, even though, on strict accounting, once electricity is fed into the national grid it doesn't substantially contribute to cutting the *district's* emissions.

Our principal recommendations

Please see the table below for a list of our suggested actions to save emissions.

Overall we believe that Winchester City Council should concentrate on what it can achieve or persuade others to achieve locally. It also needs to try to influence Hampshire County Council, the local MPs and the UK government, and large public and business organisations.

There is evidence that the majority of people are often more progressive than many politicians expect when it comes to tackling climate change.[a] Now public opinion in the UK is changing fast in reaction to 2021's extreme weather events worldwide and the warning from the United Nations that we face "Code Red for Humanity".

There is an urgent need for bold and affirmative leadership that has the courage to do what is right.

Suggested actions for the City Council which contribute to a reduction in emissions from Winchester District by 2030. *The impact of the actions, if successful, is estimated using a system of stars; * = least impact; *** = most impact. Actions in grey are where the City Council has no direct powers but has influence.*

Action	***Why?***	***How?***	***Impact to 2030***
Finance & Assets			
1. Always apply for national funding for work on climate mitigation.	Increase funding for emissions reduction actions in the district.	Apply, where appropriate with County Council or neighbouring authorities.	***
2. Use WCC investments to help achieve carbon neutrality.	Can provide worthwhile financial returns.	Invest in large-scale renewables or carbon reduction projects. Take advantage of offers from Energy4All and others.	***
3. Decarbonise Hampshire Pension Fund investments.	Investments in fossil fuels cause emissions to increase.	Press Hampshire Pension Fund to divest	**
4. Set up Green Fund or Green Bonds.	Assist projects to reduce district carbon emissions.	To be explored	*
Road transport			
5. Encourage home working.	Reduce car commuting, reduce demand for office space.	Set an example by allowing Council staff to work at home.	***
6. Make changes within the City Council's powers to deter/disincentivise use of private cars.	Hampshire car numbers have increased by 17% and vans numbers by 61% since 2005. Car mileage increased by 10% and van mileage by 35% since 2009.	Measures include: • Workplace parking levy. • Create low traffic neighbourhoods, traffic-free streets outside schools, encourage play streets, etc. • Congestion charging. • Revise car parking standards for new dwellings, and at	***

[a] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/985092/BEIS_PAT_W37_-_Key_Findings.pdf. This March 2021 UK government survey found that 80% are concerned about climate change, 70% thought that climate change was affecting people in the UK as a whole, and 34% thought that government should have the most responsibility for tackling climate change, as opposed to 26% who thought it was the general public.

		change of occupancy. • Embed 15-minute communities in Local Plan.	
7. Work with the County Council to cut emissions from road transport.	Largest source of emissions in Winchester District. Reductions have co-benefits of better air quality and health.	Measures include: • a movement strategy for every town in the district. • integrate transport carbon reduction measures into the Local Plan. • transfer funds from roads o schemes for pedestrians, cycling, or public transport including rail • make good appropriate use of UK government funding e.g. Active Travel • close all roads in Winchester town centre to private vehicles • maximise carbon reduction benefits of County Council's Local Transport Plan 4.	***
8. Improve public transport, walking and cycling.	To enable and encourage people to leave car at home.	Press Hampshire County Council to develop an ambitious Bus Service Improvement Plan. Install bus gates. Reallocation of road space to cycling, walking and buses. Improve signage.	**
9. Reduce parking spaces in towns.	To encourage people to leave car at home.	Revise the Parking and Access Strategy to put emissions reduction at its heart. Close all public car parks in towns (except for disabled drivers). Increase all parking charges in towns.	**
10. Discourage SUVs	SUVs have ½ to ¾ of mpg (emissions) of medium-sized cars. Also disproportionately damage road surfaces and verges, and are too wide for many parking spaces.	Campaign Reduce parking spaces for SUVs	**
11. Facilitate the electrification of transport, prioritising public transport (bus, trains), e-deliveries, and essentials such as medical transport and tradespeople.	Essential transport must have priority for the limited renewable electricity that will be available for transport once energy is decarbonised.	Charging points. Financial incentives e.g. parking charges for electric vehicles.	**
Cut emissions from homes			
12. Whole home retrofit of existing homes including replacing fossil fuels	Reduce emissions, with co-benefits of more comfort, better health.	*Council stock:* make maximum use of government funding schemes e.g. LAD	***

(oil/gas) with systems fuelled by low carbon energy e.g. heat pumps.		*Private:* Campaign, make maximum use of government grants, RHI or similar, fully insulate homes	
13. Replace domestic heating using fossil fuels (oil/gas) with systems fuelled by low carbon energy e.g. heat pumps.	Reduce emissions, with co-benefits of more comfort, better health.	*Council stock:* make maximum use of government funding schemes e.g. LAD *Private:* influence, work with communities to support homeowners with grants etc	***
14. Reduce emissions from gas central heating boilers.	Domestic gas emissions are 18% of district's total.	*Council stock:* Ensure all condensing boilers are correctly set up to condense efficiently *Private:* campaign to ensure all condensing boilers are correctly set up to condense efficiently; work with communities and installers	*
15. Improve energy standards of new housing.	Gas boilers likely not permitted after 2025; heat pump alternatives are available now. Reduce emissions, with co-benefits of more comfort, better health.	Apply changes expected in New Homes Standard, Building Regs.; build to Passivhaus/NEF SuperHomes standards. Do not approve new homes with mains gas or oil/LPG heating	**
16. Encourage behaviour changes e.g. optimise all central heating settings, lower room thermostat settings	Reduce emissions.	*Council stock*: Campaign. *Private:* Campaign	*
Cut emissions from non-domestic buildings			
17. Reduce electricity and gas consumption.	Electricity and gas consumption from non-domestic sector is 12.5% and 6.3% of district's total emissions respectively.	Campaign, inform building managers. Action is required in addition to the nationally driven reduction in carbon intensity of electricity up to 2024. Revisit options for local heat networks driven by heat pumps.	**
18. Retrofit of existing buildings, including replacing gas boilers with heat pump or heat network; fully insulating.	Reduce emissions, with co-benefits of more comfort, better health.	Act on Council buildings Lobby other bodies	**
19. Improve standards of new buildings.	Reduce emissions, with co-benefits of more comfort, better health.	Planning: apply changes expected in Building Regs.; aim for Passivhaus/ NEF SuperHomes standard	**
Improve energy performance of public buildings			
20. Check public building DECs are up to date.	A legal requirement. Drawing attention to the facts may prompt action.	Consult MHCLG database; apply regulations	**
21. Encourage public buildings	Some public buildings,	Campaign, present options to	**

to reduce energy consumption per square metre of floor space.	including schools and colleges, have energy/m2 well in excess of the Passivhaus standard.	building managers include aiming for higher standards (Passivhaus, NEF SuperHomes)	
Campaign for plant-based diets			
22. In public sector canteens and schools.	Reduce carbon footprint of food.	Regulations, Campaign	**
23. In restaurants and pubs.	Reduce carbon footprint of food.	Campaign restaurants and pubs	*
Land use and agriculture			
24. Planners to always prefer brownfield sites over greenfield sites.	This will protect forests and grasslands, which are both significant carbon sinks, from development and other changes in use.	Planning, Regulation	**
25. Discover why agriculture emissions are increasing.	14.2% increase in emissions since 2013 and now back to 2006 levels. No publicly available data on energy use by farms.	Work with South Downs National Park Authority to build on / replicate their work with farmers. Disseminate good practice on land use and regenerative agriculture. Encourage all landowners to measure their carbon footprint using one of the three UK market leading apps.	*
26. Provide land for allotments.	Home grown food cuts emissions; co-benefits of health and exercise.	Allocate land in the district – including in the Local Plan.	*
Emissions from business and industry			
27. Discover why 'business parks' in Curdridge & Durley have high energy consumption and take appropriate action.	They contribute almost 25% of the district's industry and commercial emissions.	Consult businesses.	***
28. Find ways to extract energy consumption and residual fuel data relating to businesses and industry	Around 30 businesses employ over 250 people and are likely to be the biggest business emitters in the district.	Consult with larger businesses; ask businesses to approach BEIS to remove current restrictions on publicising their metered energy consumption.	*
29. Support the revival of the Hampshire Bank.	Will fund green businesses.		*
30. Make a "circular economy" the aim of the Green Economic Plan.	A circular economy reduces the use of new materials in manufacturing.	Add to the Green Economy 10 year strategy.	**
31. Encourage low-carbon economy businesses.	Low carbon businesses reduce emissions.	Provide premises for low-carbon start-ups.	*
Renewable energy generation			
32. Encourage developers to submit proposals for large-scale renewable energy generation.	Renewable energy generation contributes to meeting UK emissions target	Promote renewable energy production in new developments. Identify sites for wind and solar power in Local Plan.	***

		Facilitate commercial development in suitable locations.	
33. Support communities to create their own renewable energy schemes.	Both a contribution to low carbon energy and to strengthening community determination to act on the climate crisis.	Support messaging via parish councils and WeCAN. Offer planning advice.	*

Introduction

The report is in four parts:

Part 1 - Data

We present annual data, mainly from BEIS, to show what has been happening in Winchester District since 2005.

Part 2 - Trends

This part covers trends in the data, what they tell us and, where feasible, our ideas about the underlying causes and what they mean for the future.

Part 3 - Action

This investigates a range of scenarios, both quantitatively and qualitatively, for saving emissions over the nine years from 2022 to 2030. We include the local impact of possible Government changes, and of changes by individuals, homeowners and communities. We conclude with a table of actions that could be taken by Winchester City Council directly, or by influencing others to act.

The list is not exhaustive. We concentrated on actions which we think have a high priority because they could have the biggest impact and can be influenced by the City Council.

Our recommendations do not distinguish between actions that are already being taken by the City Council and new actions, because we intend the table to help with prioritising all mitigating actions.

Part 4 – Background resources

This part of the report provides links to other data sources and resources relevant to setting priority action in Winchester District, which may be useful to anyone who wants to go into more detail on the material or recommendations in this report.

Part 1. Estimates of energy consumption and emissions in the Winchester District

Part 1 summarizes government statistics published by the UK government's Department for Business, Energy, and Industrial Strategy (BEIS) for energy use and carbon dioxide (CO_2) emissions in the Winchester District for the years 2005 to 2019.

For more technical background please refer to the Appendix – Technical Background (p.79).

Other data available at different geographical scales

Most of the data presented in this report is for the Winchester District, one of 317 local authorities in England. BEIS also reports data at the national and regional level (31 regions) and has defined two levels of 'super output areas' for reporting on smaller areas within local authorities.[1] BEIS is also providing postcode level data on an experimental basis for domestic gas and electricity consumption.

Energy consumption in the Winchester District

BEIS publishes energy consumption data at the local authority level for Electricity, Gas, Transport fuels and Residual fuels. Figure 1 illustrates the relative amounts of energy from each source consumed in Winchester District.

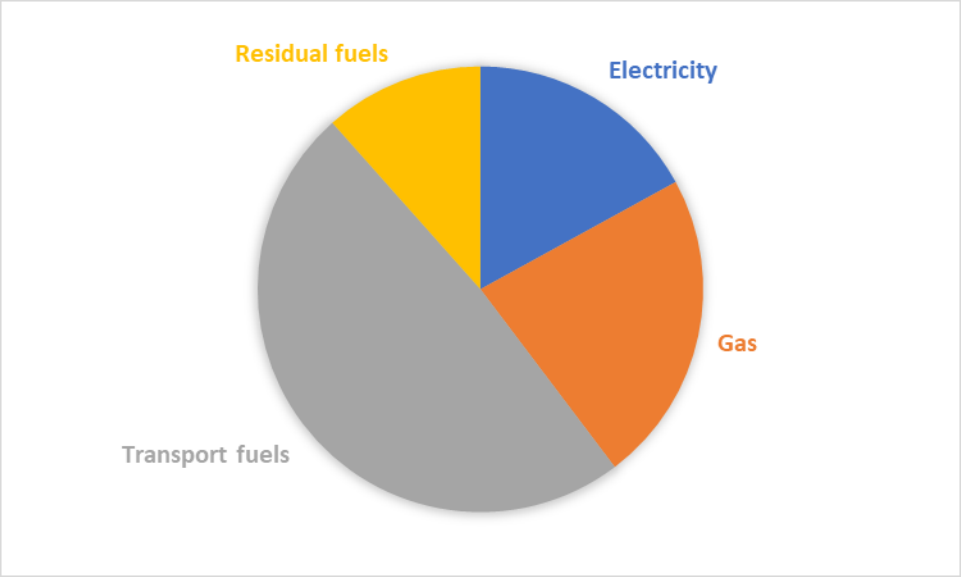


Figure 1. Relative amounts of energy consumed for the main fuel categories in the Winchester District. Figures are for 2019 except residual fuels where the 2018 value has been used.

Electricity

Figure 2 plots the yearly totals reported by BEIS for metered electricity consumption in the Winchester District from 2005 to 2019.

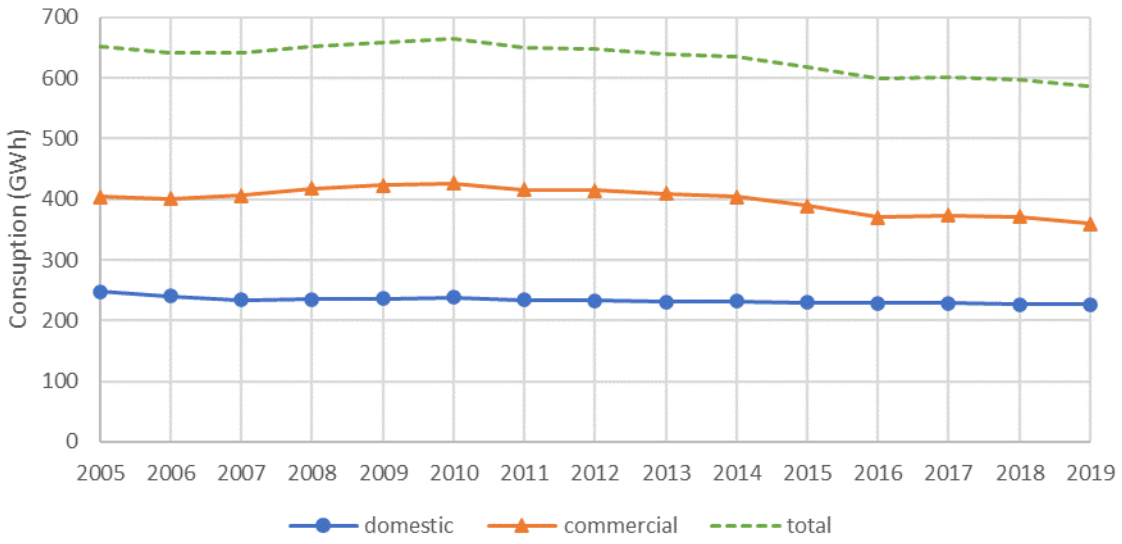


Figure 2. Total annual metered electricity consumption in Winchester District 2005-2019 from the domestic and commercial plus industrial sectors. 'Domestic' includes some small businesses. Based on data from BEIS[2].

Table 1 summarizes the 2019 figures with a comparison with the previous year.

Table 1. Winchester District electricity consumption in 2019 compared with 2018. † The average for Great Britain was 3811 kWh.

	Domestic	**Industrial and commercial**	**Total**	**Average domestic per household**
2019	226 GWh[b]	360 GWh	586 GWh	4518 kWh†
vs 2018	0%	-3%	-2%	-0.7%

BEIS made small revisions since the figures for 2018 were first published. These resulted from some consumption billed as half-hourly as being re-classified as domestic, and from improved postcode mapping resulting in fewer 'unallocated' meters.

Figure 3 shows the relative changes in these figures compared with the baseline year of 2005. Domestic consumption has been slowly decreasing since 2010, except for 2014 when there was a slight increase. Commercial consumption declined since the 2010 peak although there is no obvious explanation for this as the number of customers remained essentially constant. Commercial electricity consumption has also fallen faster than domestic consumption since 2010; in 2019 it has for the first time fallen significantly further than domestic consumption in relative terms compared with 2005 – 89.1% vs 91.5%.

[b] 1 GWh = 1 million kWh

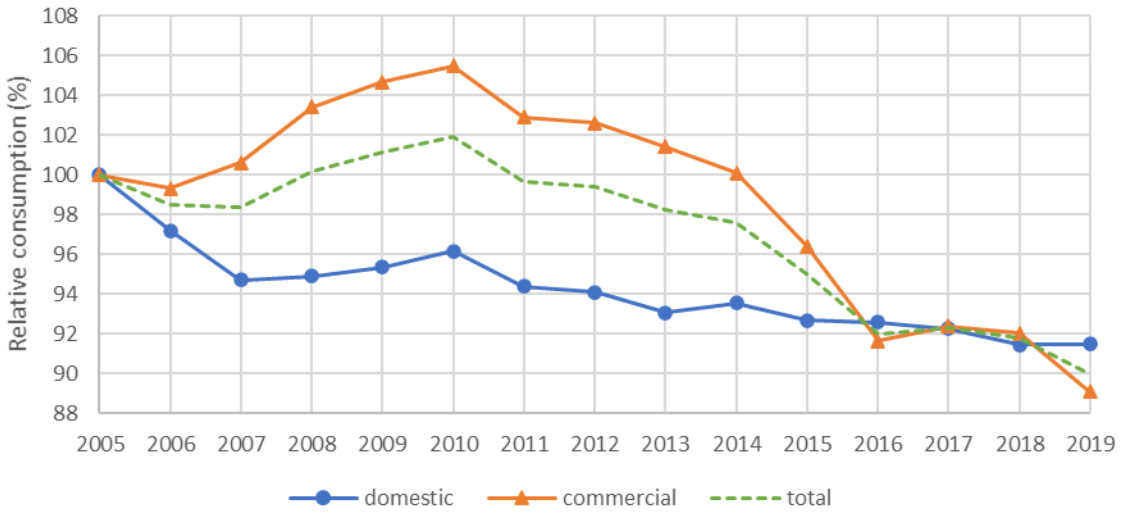


Figure 3. Annual metered electricity consumption for Winchester District from 2005 to 2019 plotted as a percentage of 2005 values. Based on BEIS[2].

Gas

Figure 4 plots figures reported by BEIS for annual metered gas consumption by the whole of the Winchester District for the years 2005-2019 from the domestic and commercial sectors. The 'domestic' sector is defined as consumers consuming less than 73,200 kWh which across the UK includes around 2 million businesses. The spike in electricity consumption in 2010 is not present in the gas figures, presumably due to the weather correction of gas consumption figures.[3] The apparently anomalous 2005 figure for commercial consumption is ignored in the discussion below.

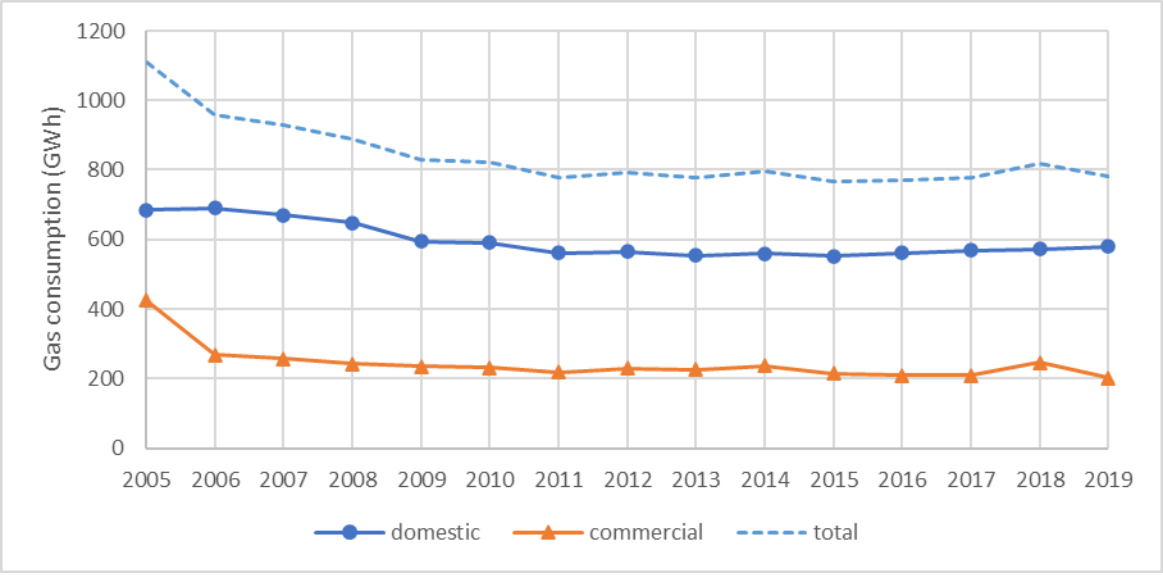


Figure 4 Weather-corrected total annual metered gas consumption in the Winchester District 2005-2019 from the domestic and commercial plus industrial sectors. Based on figures from BEIS[4]. The 2005 figure for commercial consumption appears anomalous.

In contrast to electricity, domestic consumption of gas – used for heating and hot water - exceeds commercial consumption.

Table 2. Gas consumption in the Winchester District 2019 vs 2018. † vs 13,495 kWh average for Great Britain.

	Domestic	Industrial and commercial	Total	Average domestic per household
2019	684 GWh	424 GWh	1,108 GWh	13,917 kWh†
vs 2018	+1.3%	-17.7%	-4.4%	+0.1%

Figure 5 plots the same figures relative to the 2006 figures.

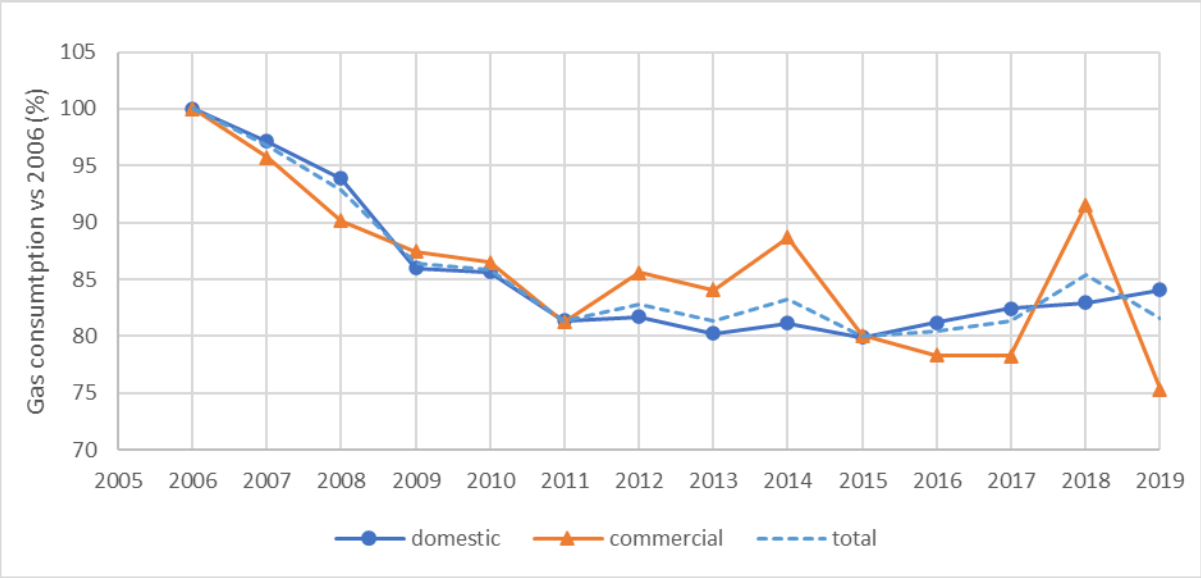


Figure 5. Winchester District annual gas consumption for the domestic and commercial sectors relative to 2006.

After steady decreases in gas consumption up to 2011 there has been a steady increase in domestic consumption since 2015. 2019 has seen a decrease in the commercial sector but this merely balances the fairly significant increase in 2018. Overall total gas consumption has declined by around 18.4% relative to 2006. We do not know what caused the apparent spike in commercial gas consumption in 2018.

As expected, domestic gas consumption per consumer has fallen in most years (Figure 6), presumed to be due to the continued roll-out of condensing boilers. Thus, because domestic gas consumption across the district has increased recently this is likely to be due to an increase in the number of gas consumers in new homes.

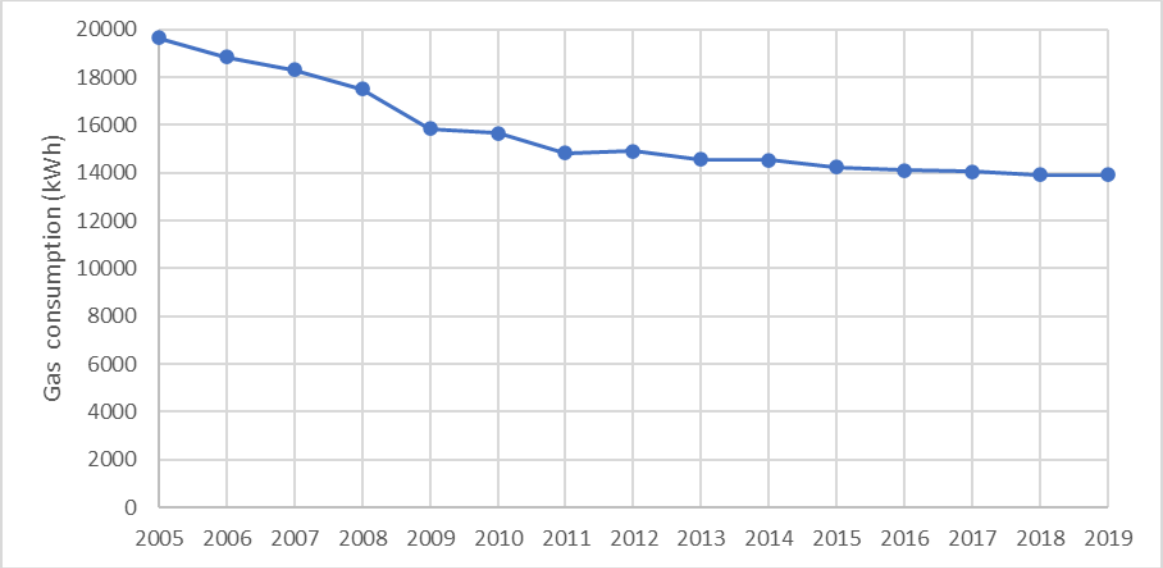


Figure 6. Gas consumption per domestic consumer in the Winchester District from 2005-2019.

Road Transport Fuels

Figure 7 plots the consumption for each of the four vehicle classes across all road types during the calendar year 2019, together with 50% of the total. Figures for buses and motorcycles are relatively small (between 2.5 and 4 ktoe) and are neither shown nor included in the total.[c]

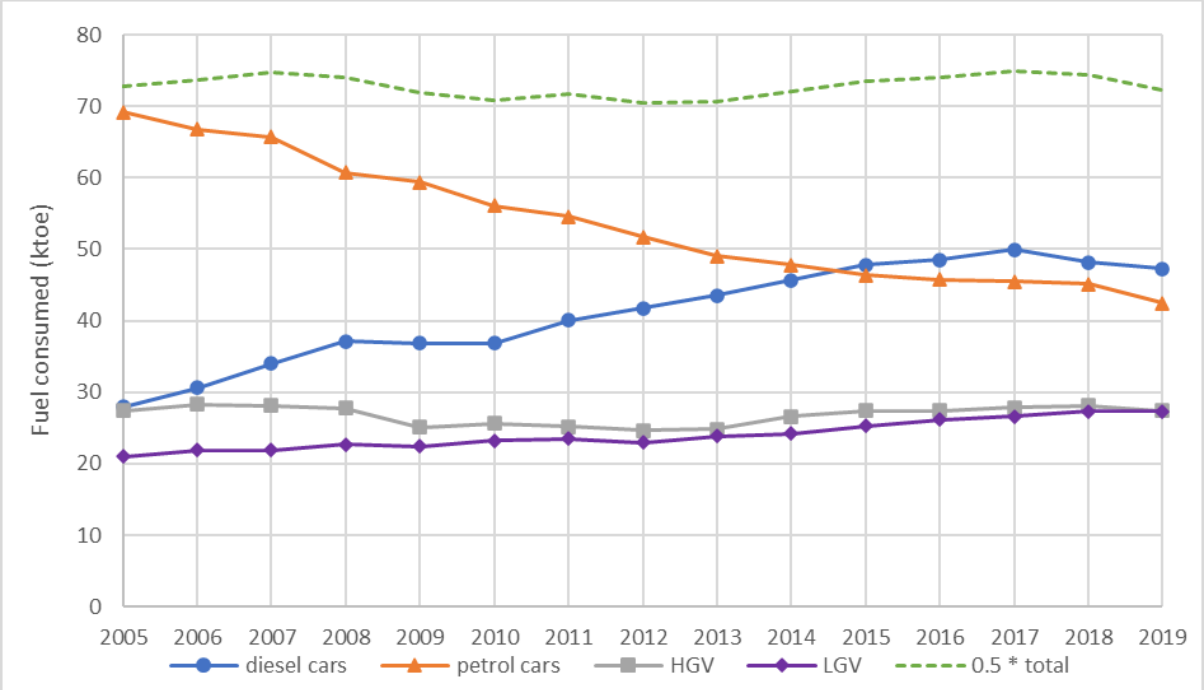


Figure 7. Road vehicle fuel consumption on all types of road in the Winchester District for the years 2005-2019. Based on BEIS figures[5]. Units of consumption are ktoe (thousands of tonnes of oil equivalent) where 1 ktoe = 11.63 GWh. 50% of the total is plotted rather than the full value to aid readability.

[c] However, bus fuel consumption figures were included in the total for the previous year's report.

Table 3 summarizes the 2019 figures and the changes from 2018 to 2019.

Table 3. Transport fuel energy consumption for major fuel users comparing 2019 to 2018.

	Diesel cars	Petrol cars	HGV	LGV	Total
2019 ktoe	47.27	42.45	27.4	27.3	144.5
Compared to 2018	-1.8%	-5.9%	-2.4%	+0.1%	-2.82%

The trend away from diesel cars to petrol cars noted in the 2018 figures due to the emissions scandal seems to have slowed with petrol falling much faster than diesel in 2019. In fact, petrol car energy consumption in the Winchester District fell considerably by 5.9% between 2018 and 2019 mirroring a national drop of around 4.5%, although we don't know why these apparently large decreases occurred.

HGV fuel consumption also fell in 2019, in contrast to the almost unchanged LGV fuel consumption.

An updated benchmarking exercise increased estimates for traffic flow on minor roads for the years 2010 to 2018[6].

Figure 8 plots the change in transport fuel consumption for cars and goods vehicles since 2005.

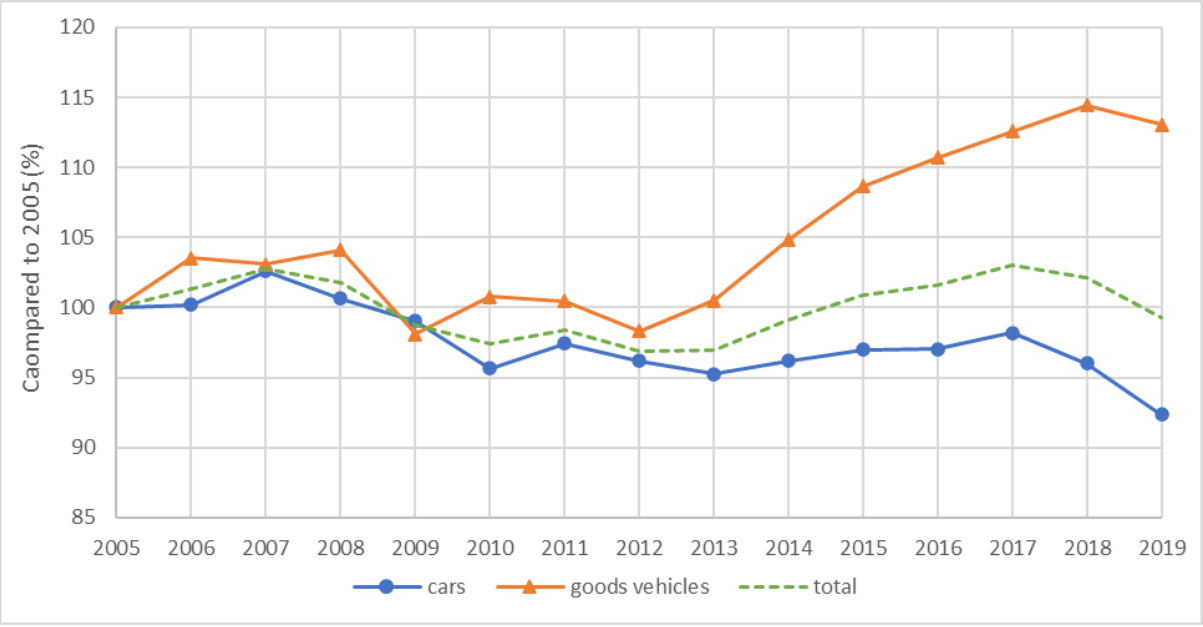


Figure 8. Trends in transport fuel consumption 2005-2019 relative to 2005.

The overall consumption in 2019 was only marginally lower (less than 1%) than in 2005, despite improvements in engine efficiencies with the reduction in consumption by cars being almost balanced by the smaller increase in consumption by goods vehicles (Figure 7). The relative dips in consumption in 2013 and possibly in 2019 may reflect a higher fuel price at the time[7].

Residual fuels

Figure 9 plots the consumption of residual fuels in the Winchester District from 2005 to 2019.

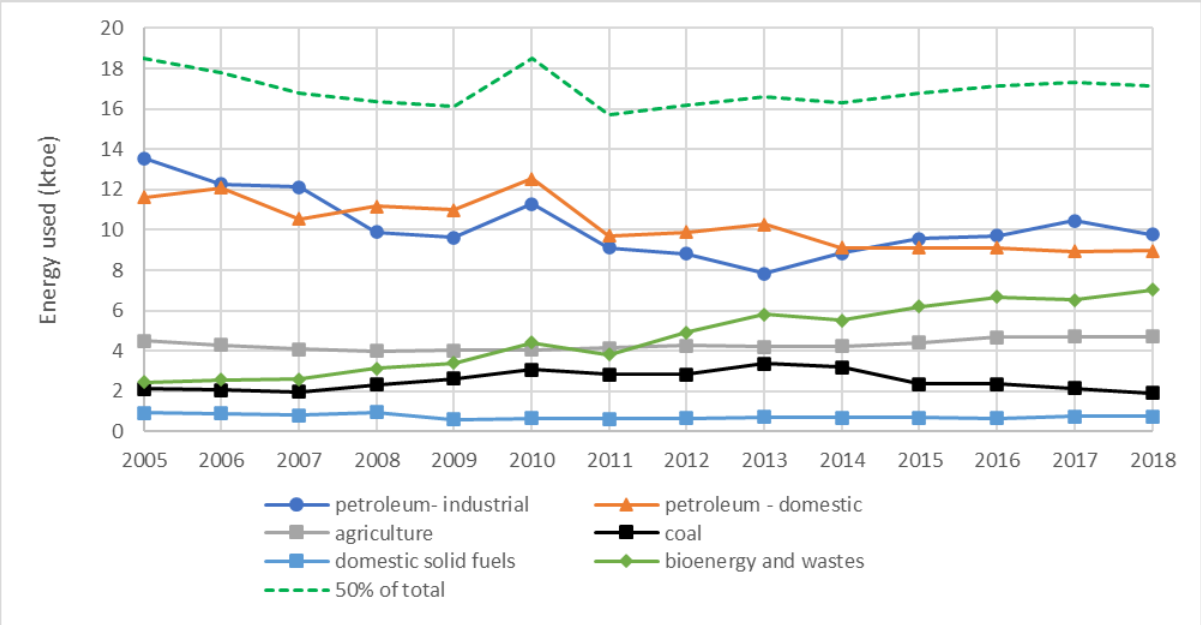


Figure 9. Consumption of residual fuels (also referred to as other fuels) in the Winchester District in 2018. Based on figures from BEIS[8]. Total is shown as 50% of actual. Units are kilotonnes of oil equivalent (ktoe). Agriculture only includes petroleum with the small amount of coal used in agriculture included in the coal total.

Overall consumption has stayed about the same with decreases in coal, and a 14.2% increase in agricultural use since 2013. The marked peaks in petroleum consumption in the cold year of 2010 reflect the fact that much of it is used for heating. The consumption of bioenergy and wastes has consistently risen through the period covered.

Table 4 summarizes the changes from 2017 to 2018 for residual fuels.

Table 4. Residual fuels change from 2017 to 2018.

	Petroleum industrial	Petroleum domestic	Agriculture	Coal	Solid fuels	Bioenergy & wastes	Total
2018 ktoe	9.8	9.0	4.7	1.9	0.8	7.0	34.3
vs 2017	-6.5%	+0.3	+0.2	-11.4	+2.8	+7.5	-1.1

Figure 10 shows the trends in consumption of residual fuels showing clearly the decline in coal use and the rise in biofuels and wastes.

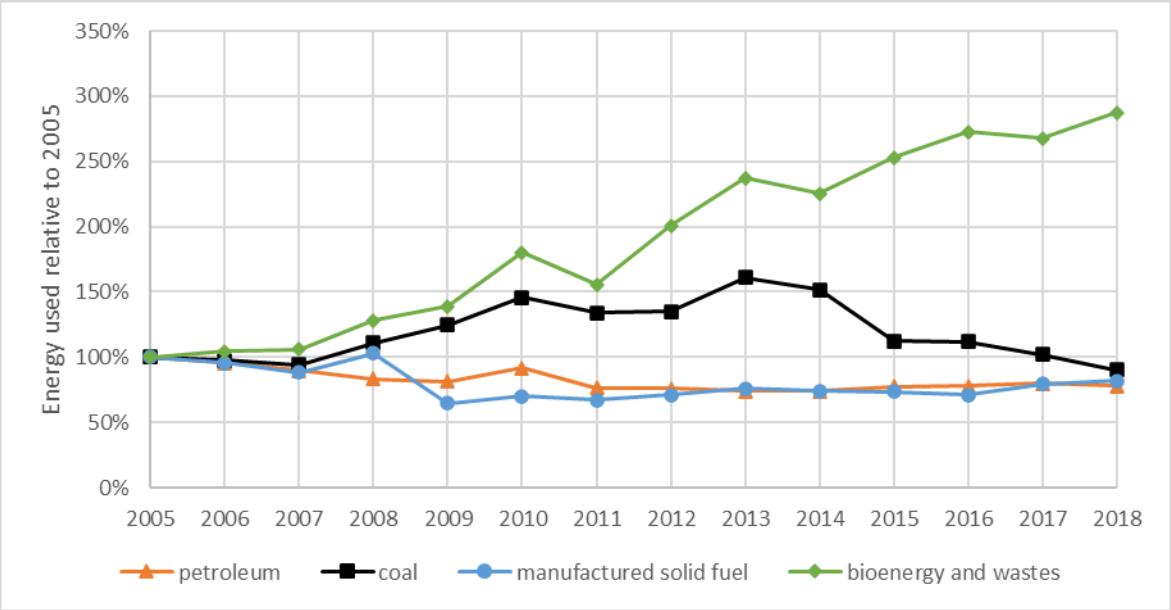


Figure 10. Trends in residual fuels consumption in the Winchester District from 2005-2018 relative to 2005.

CO_2 Emissions

Estimated national CO_2 emissions from all domestic, commercial, industrial, and agricultural fuel, gas and electricity use, as well as emissions associated with road transport and land use change (LULUCF), are reported by BEIS for each calendar year.[d] National emissions are disaggregated on an end-user basis, sometimes using additional data, to estimate CO_2 emissions in local authority areas.[9] Emissions from international shipping and international and domestic aviation are excluded. Emissions data are given for carbon dioxide (CO_2) only.

The 2019 figures for non-domestic emissions for electricity, gas and residual fuels, previously reported as simply 'industry and commercial', have now been separated by BEIS into three categories: industry, commercial and public sector– see Table 5.

Table 5. Definition of sectors for CO_2 emissions split between industrial, public sector and commercial. Based on the ONS Standard Industrial Classification (SIC) system[10].

Sector	SIC 2007 subsections
Industrial	01-32: • section A – agriculture, forestry and fishing • section B - mining and quarrying, • section C – manufacturing excluding subsection 33 (repair and installation of machinery and equipment) 35–39: • section D - Electricity, gas, steam and air conditioning supply

[d] All the data in this section come from the latest version at https://www.gov.uk/government/statistics/uk-local-authority-and-regional-carbon-dioxide-emissions-national-statistics-2005-to-2019 (downloaded in July 2021). Email from Georgina Smalldridge, BEIS (1/7/2020) confirmed calendar year reporting.

	• section E – water supply, sewerage, waste management and remediation activities 42: civil engineering
Public sector	84 – public administration and defence, compulsory social security 85 – education 86 – human health activities 87 – residential care activities
Commercial	All other subsections

BEIS also provides this split for previous years – although for all years prior to 2010 the split for 2010 was applied.[12,11] BEIS also changed the modelling of LULUCF CO_2 emissions based on IPCC methodology, which have also resulted in significant revisions for previous years in some regions[12], although figures for the Winchester District have been only slightly affected.

BEIS also reports CO_2 emissions for 'large industrial installations' - for example steelworks, and cement manufacturers - but there weren't any of these in the Winchester District during the relevant period (2005-2019).

Electricity

Figure 11 shows the emission trends for electricity.

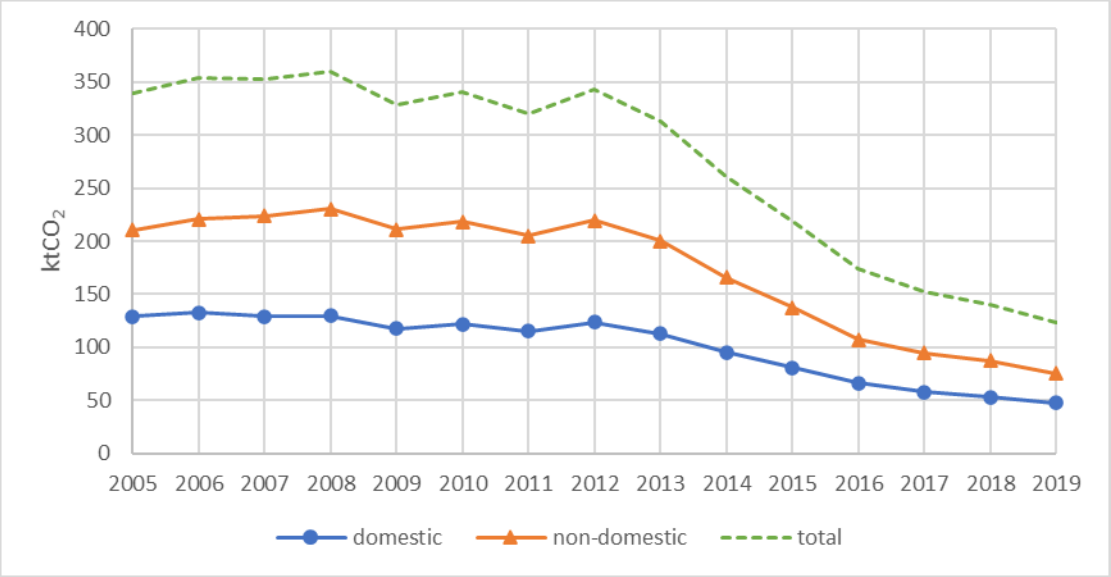


Figure 11. Electricity-related CO_2 emissions from the Winchester District 2005-2019. Based on modelling by BEIS[13].

As expected, emissions from electricity continue to fall as coal power stations are phased out and the share of renewable energy increases. An 'emission factor' which decreases year-on-year to reflect the decrease in emissions from electricity generation is used to convert electricity consumed (in GWh) to CO_2 emissions ($ktCO_2$).[14]

Table 6 summarizes the changes from 2018 to 2019.

Table 6. Electricity CO_2 emissions in the Winchester District. 2019 vs 2018

	Domestic	Non-domestic	Total
2019	47.4 $ktCO_2$	75.3 $ktCO_2$	122.7 $ktCO_2$
vs 2018	-10.7%	-13.6%	-12.5%

Figure 12 shows the new data splitting non-domestic electricity emissions across industry, commercial and public sector. In the Winchester District the largest of these sectors is commercial.

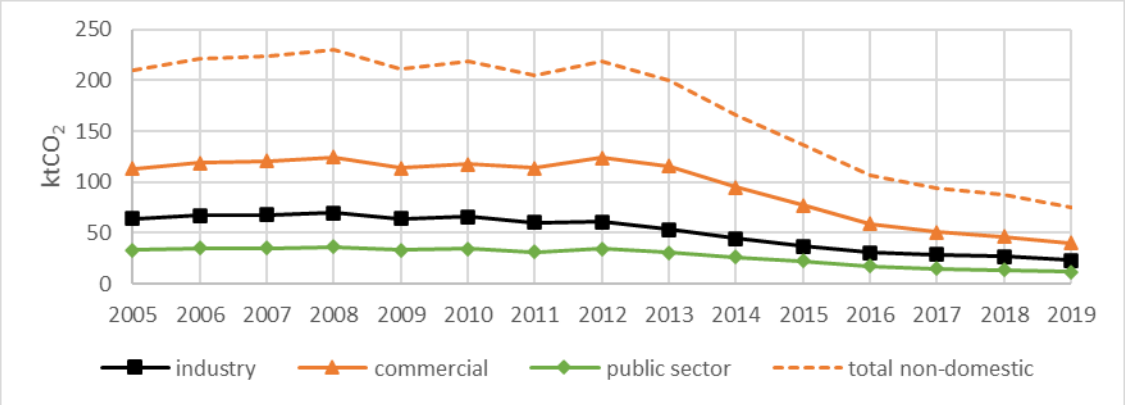


Figure 12. Split of non-domestic electricity emissions in the Winchester District 2005-2019. This was previously all classified as 'industry and commercial'. Pre-2010 figures modelled on 2010 split.

Gas

Figure 13 plots the estimated gas-related CO_2 emissions for the Winchester District from 2005-2019.

Slightly different emission factors were used for different years[15], partly to correct for the fact that the sub-national gas consumption statistics are weather corrected. Thus, in these figures the cold winter of 2010 shows as a distinct peak and the multi-year trends are less distinct.

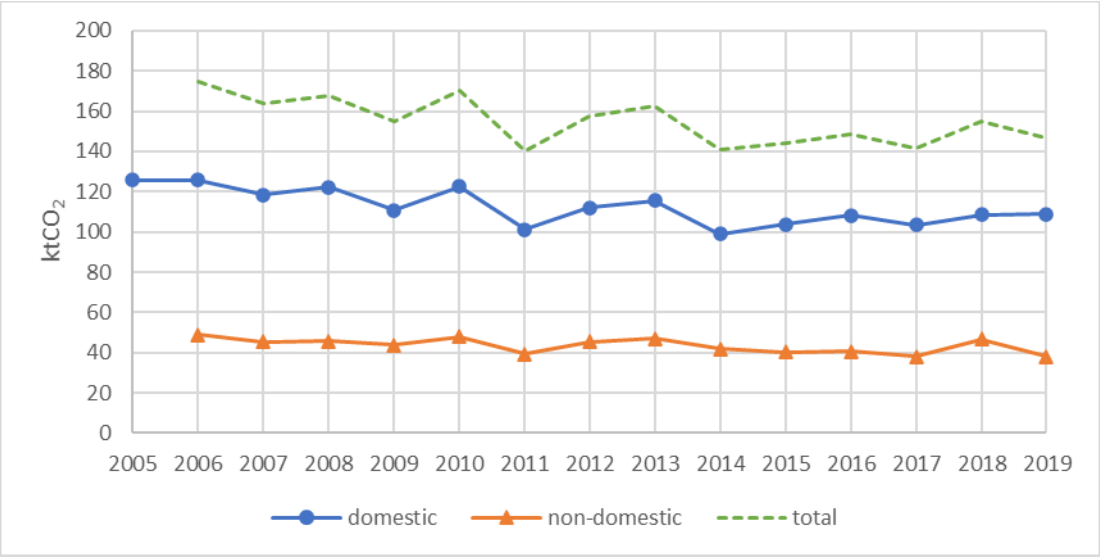


Figure 13. Gas consumption related CO_2 emissions for the Winchester District 2005-2019. The figure for non-domestic gas emissions for 2005 seems anomalous and is omitted.

Gas emissions essentially follow gas consumption including the rise in non-domestic emissions in 2018 with a corresponding fall in 2019.

Table 7.Summary of changes from 2018 to 2019 in CO_2 emissions related to gas consumption for the Winchester District.

	Domestic	Non-domestic	Total
2019	109.0	37.9	146.9
vs 2018	+0.3%	-18.5%	-5.3%

Figure 14 shows non-domestic gas emissions split between industry, public-sector and commercial emissions with commercial usually being the highest. All three sectors show a similar increase in 2018 followed by a decrease in 2019.

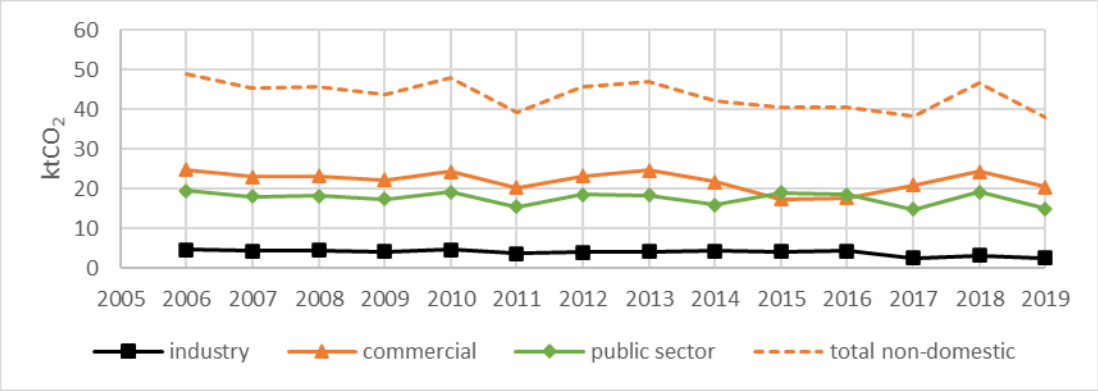


Figure 14. Non-domestic gas emissions split for the Winchester District 2006-2019.

Road transport

Figure 15 charts the annual CO_2 emissions from road transport since 2005 in the Winchester District. BEIS does not distinguish between different vehicle classes in these figures. The non-motorway-associated emissions are separated out in the lower curve as these probably represent a higher proportion of local traffic compared with motorway traffic.

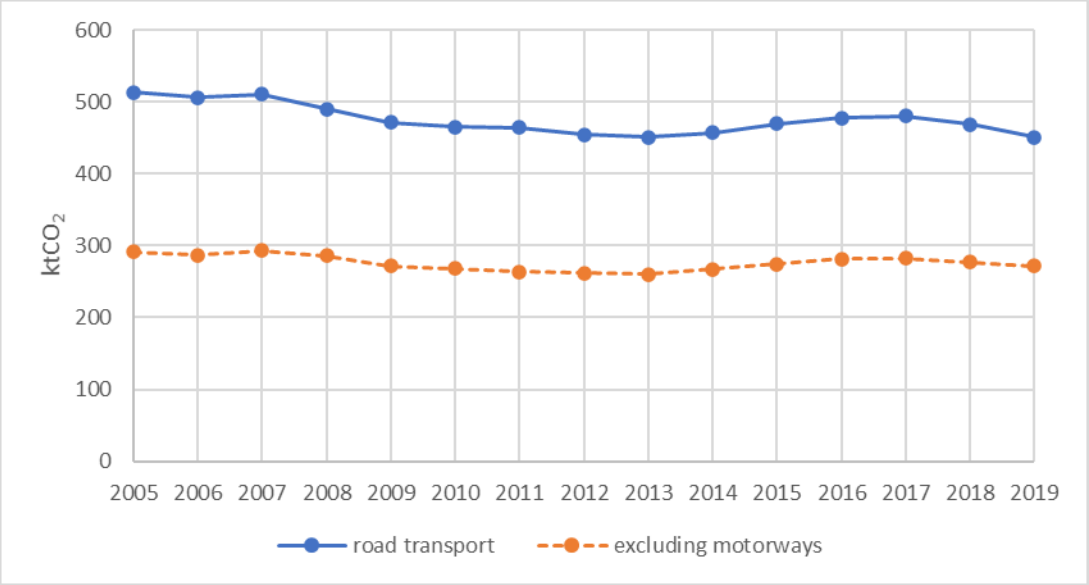


Figure 15. Annual CO_2 emissions from road transport in the Winchester District 2005-2019. The lower curve includes all road types except motorways.

Table 8 summarizes the changes in 2019 which continue a falling trend since 2018 showing a significant fall in motorway traffic emissions. The emission conversion factors for transport fuels used to calculate these figures have not changed significantly recently[16].

Table 8. Changes in transport fuel CO_2 emissions 2018-2019. in the Winchester District.

	All traffic	Non-motorway traffic	Motorway traffic
2019	450.6 $ktCO_2$	271.7 $ktCO_2$	179.0 $ktCO_2$
vs 2018	-3.8%	-1.9%	-6.7%

Residual fuels and agriculture emissions

Figure 16 plots the CO_3 residual fuels and agriculture emissions for the Winchester District 2005-2019.

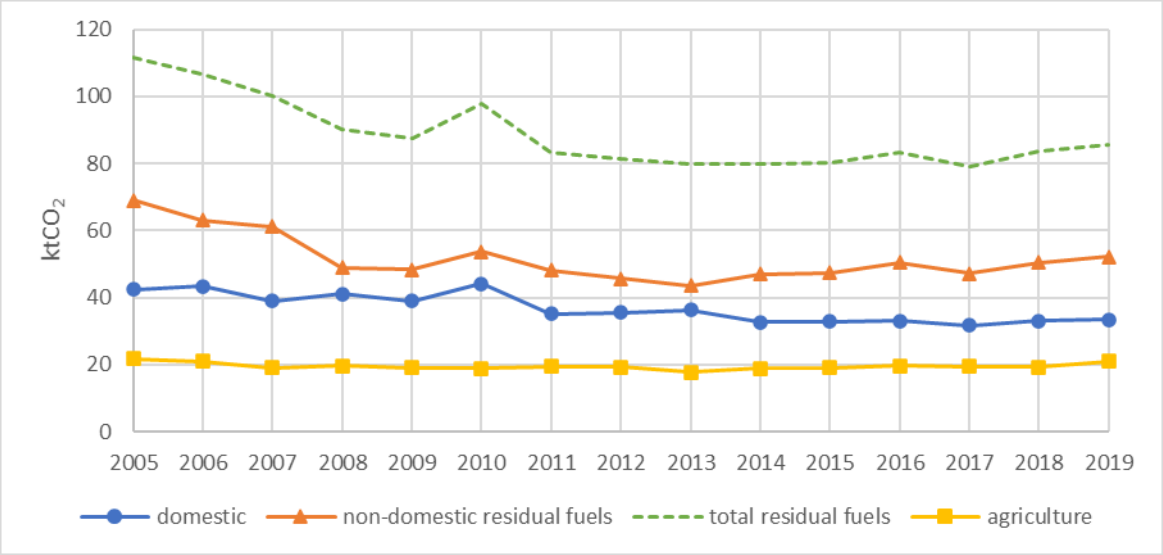


Figure 16. Annual CO_2 emissions in the Winchester District from residual fuels and agriculture 2005-2019.

Residual fuels CO_2 emissions, in contrast to gas emissions, continued the increase exhibited in 2018. Agriculture also showed a marked increase after a long period of stability. Table 9 summarizes the changes from 2018 to 2019.

Table 9. Changes in residual fuels and agriculture CO_2 emissions in the Winchester District 2018-2019.

	Domestic residual fuels	Non-domestic residual fuels	Total residual fuels	Agriculuture
2019	33.4 $ktCO_2$	52.2 $ktCO_2$	85.7 $ktCO_2$	20.9 $ktCO_2$
vs 2018	+0.8%	+3.4%	+2.4%	+8.7%

Figure 17 shows the breakdown of CO_2 emissions from non-domestic residual fuels showing that industry is by far the dominant emitter for this fuel classification.

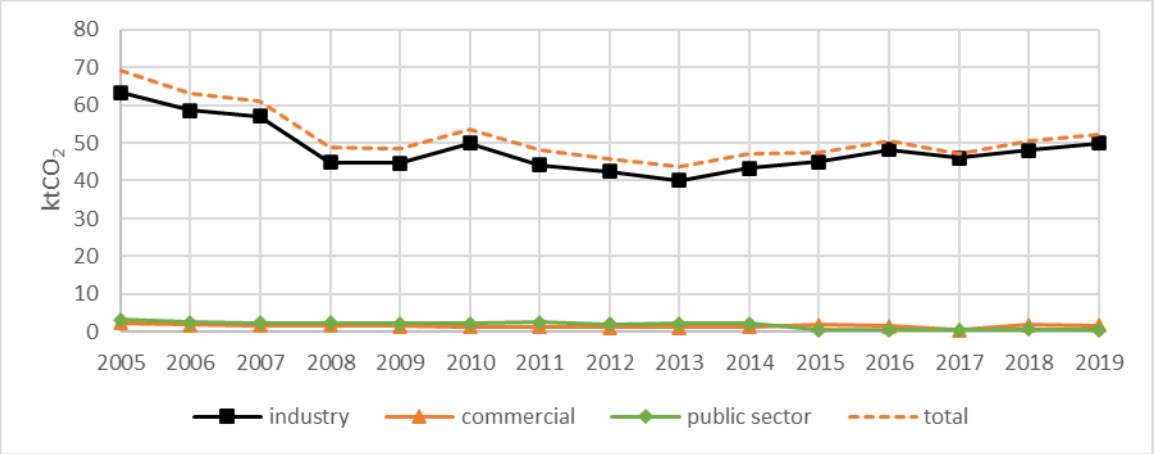


Figure 17. Breakdown of non-domestic CO_2 emissions from residual fuels in the Winchester District 2005-2019.

Emissions from land use, land use changes and forestry

Emissions from land use, land use changes and forestry (LULUCF) across the UK have been modelled since 1990. BEIS takes the lead in the UK in preparing the annual Inventory of Greenhouse Gas Emissions for the United Nations Framework Convention on Climate Change. BEIS contract Ricardo Energy & Environment to compile the overall greenhouse gas emissions inventory and they in turn subcontract the Centre for Ecology and Hydrology and Forest Research to prepare the data. The uncertainties in calculating the LULUCF inventory are described in the National Inventory Report[17] and range from 12-80% for CO_2 in 2019 depending on the LULUCF sub-sector. Additional uncertainty is associated with disaggregating the dataset to local authority level; this is estimated to be in the range of 20-30 % on decadal timescales, though probably higher for annual estimates.[18]

A significant recalculation of BEIS figures for previous years has resulted in a large reduction in the estimate of the net amount of CO_2 absorbed nationally in the UK[19]. When combined with data on other greenhouse gases – notably methane (CH_4) which is emitted from degraded peatlands – the LULUCF sector has changed from being a significant sink for greenhouse gases to a significant source[20]. For CO_2 emissions specifically the LULUCF sectors most significantly affected by these changes are conversions to and from cropland and grassland.

However, the adjustments for overall Winchester District LULUCF CO_2 emissions for previous years are small with changes to different categories balancing out. Table 10 shows the adjustments to the 2018 figures.

Table 10. Adjustment made to 2018 Winchester District LULUCF CO_2 emissions in the 2019 figures by BEIS. All quantities are in units of $ktCO_2$.

	Forest	Cropland	Grassland	Wetlands	Settlements	Harvested wood products	**Net emissions**
Original	-59.2	20.7	-34.0	0.0	23.3	0.0	-49.1
Adjusted	-57.4	20.5	-32.4	-0.1	20.2	0.0	-49.2

Figure 18 shows the LULUCF figures for the Winchester District for 2005-2019. The figures are plotted as $ktCO_2$ rather than ktC (kilotonnes of carbon[e]) as in WinACC's last report[21]. The net emissions are negative; in other words the LULUCF sector was a net absorber of CO_2.

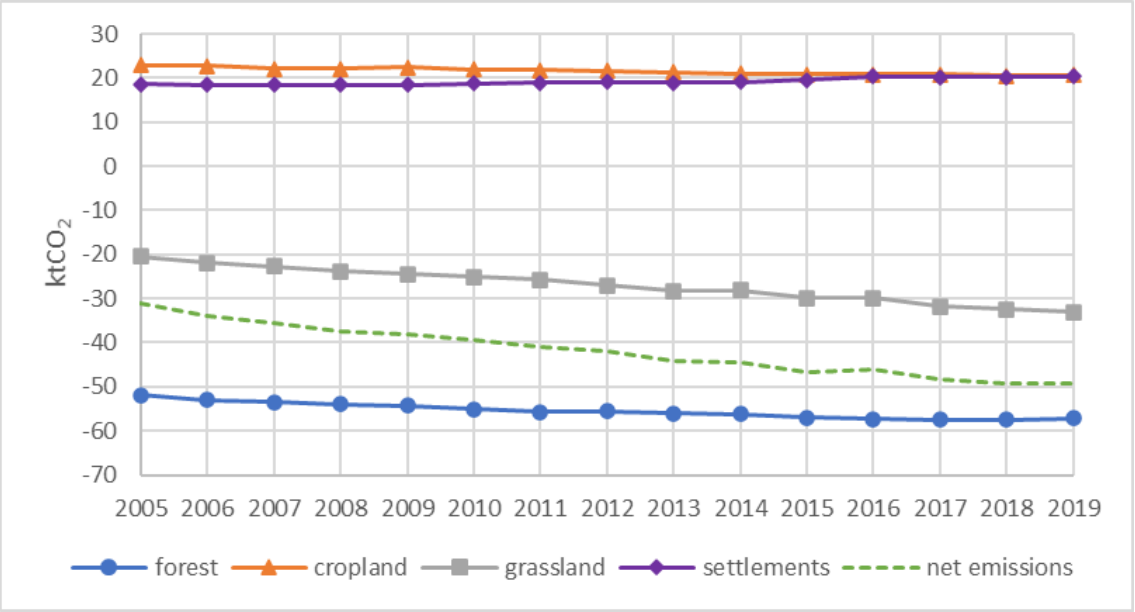


Figure 18. LULUCF CO_2 emissions in the Winchester District 2005-2019. Note that some emissions figures including the net total are negative indicating net absorption of CO_2.

Emissions by sector

Figure 19 shows the contributions to CO_2 emissions from each sector in the Winchester District. Only electricity has shown a consistent decrease with road transport being by far the biggest contributor in 2019, even excluding motorway traffic.

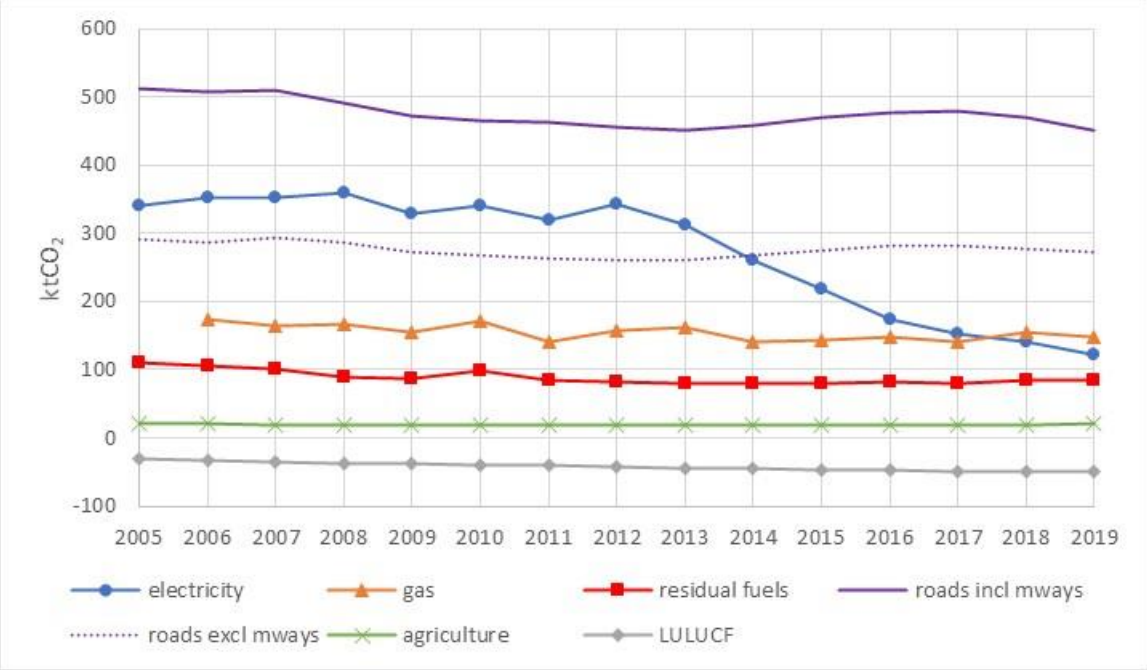


Figure 19. CO_2 annual emissions in the Winchester District 2005-2019 illustrating the relative contributions of each sector.

[e] 1 ktC = 3.67 $ktCO_2$

Figure 20 shows the relative changes in each sector from 2005-2019.

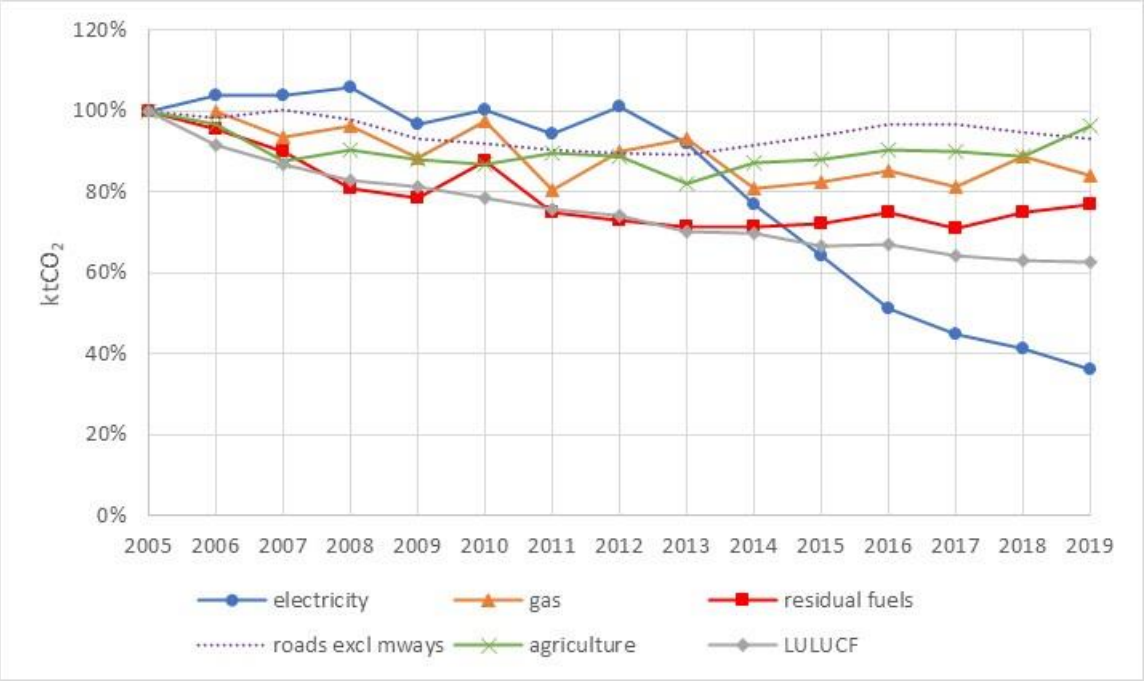


Figure 20. Relative emissions in the Winchester District showing how each sector has performed from 2005-2019. Road transport including motorways has been omitted but shows a very similar trend. LULUCF is artificially plotted as the inverse percentage to demonstrate the increasing negative emissions.

Over the period 2005-2019 electricity emissions have fallen consistently due to changes in generation away from coal to gas and renewables. Gas and residual fuels have shown initial progress but seem to have stalled somewhere below 80% of 2005 levels. Agriculture has risen back almost to 2005 levels after earlier reductions while LULUCF, while a minor contributor currently, continue to absorb more CO_2.

Overall, CO_2 emissions are mostly a function of the growth of renewables and the retiring of coal for electricity generation, alongside the introduction of nominally more efficient condensing gas boilers, which use less mains gas. Transport remains the dominant emitter. These results are described in more detail in Part 2.

Summary CO_2 emission statistics for Winchester District

Table 11 summarises and compares the total CO_2 emissions for Winchester District for the years 2005 and 2019.

Table 11. Summary of annual direct CO_2 emissions for the Winchester District published by BEIS for the years 2005-2019 and the net changes over that period.

Figures in brackets exclude emissions from vehicles on motorways.

Domestic and non-domestic subtotals are for electricity, gas and residual fuels only.

† 2006 figure used for non-domestic gas consumption instead of the apparently anomalous 2005 figures.

‡ this is actually an increase in negative emissions.

* diesel trains, inland waterways, heritage railways etc.

** Note that the 2005 split between industry, commercial and public sector is taken from the 2010 figures so is not reliable.

Sector	Sub-sector**	2005 ($ktCO_2$)	2019 ($ktCO_2$)	Decrease (%)
Electricity	Domestic	129.0	47.4	63.3
	industry	63.8	23.4	63.3
	commercial	113.5	40.2	64.6
	public sector	33.2	11.8	64.5
Gas	Domestic	125.7	109.0	13.3
	industry†	4.7	2.5	46.8
	commercial†	24.8	20.5	17.3
	public sector†	19.4	14.9	23.2
Road transport		513.0 (291.6)	450.6 (271.7)	12.2 (6.8)
Residual fuels	domestic	42.4	33.4	21.2
	industry	63.4	50	21.1
	commercial	2.4	1.7	29.2
	public sector	3.3	0.6	81.8
Agricultural fuels		21.7	20.9	3.6
LULUCF (net)		-31.0	-49.3	59.0‡
Miscellaneous transport*		4.8	4.4	8.3%
Domestic subtotal		297.2	189.8	36.1
Non-domestic subtotal†		328.4	165.5	49.6
Total Direct Emissions		**1134** (913)	**782** (603)	**31.0** (34.0)

Figure 21 shows the same data as Table 11 plotted graphically to aid visualization

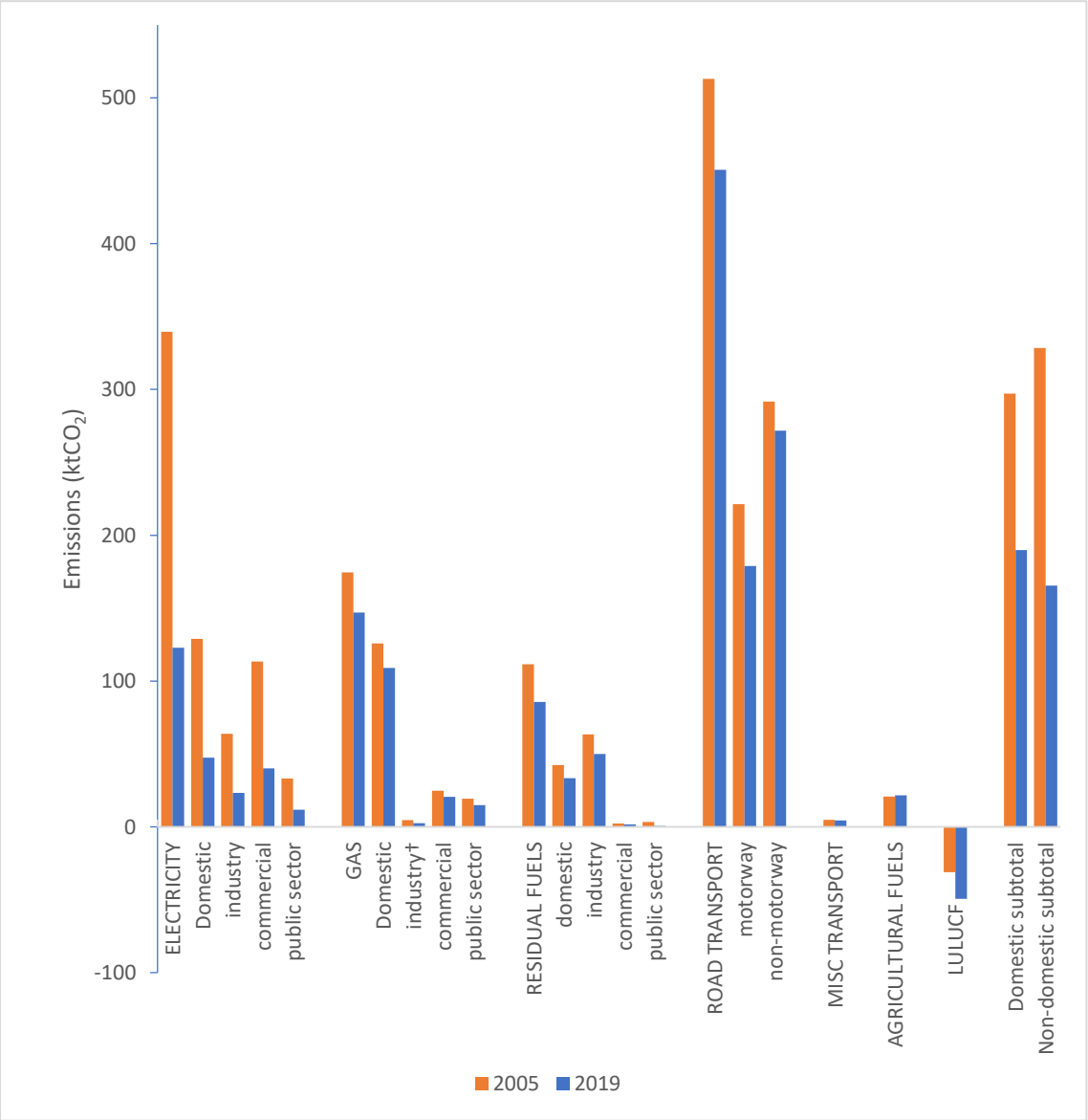


Figure 21. Plot of data from Table 11 comparing 2005 emissions with 2019 emissions by category. Major category labels are in upper case while sub-categories are in mixed case.

Other emissions datasets

The Centre for Sustainable Energy (CSE) with the University of Exeter has published figures for both territorial and consumption emissions.[22] In principle the territorial emissions data should be comparable with the BEIS figures described in this document while the consumption figures reassign the same emissions worldwide to the consumer who 'caused' them.

CSE reports emissions as tonnes of carbon dioxide equivalent (e.g. $ktCO_2e$) although most categories reported here emit only CO_2 emissions so the CSE figure can be considered as approximately the same as $ktCO_2$.

Table 12 compares figures reported by CSE to equivalent BEIS categories where they exist.

Table 12. Territorial emissions reported by CSE for the Winchester District compared to equivalent BEIS data.

CSE category	**$ktCO_2e$**	**BEIS category (2019 figures)**	**$ktCO_2$**
Housing - Mains gas	105.0	Domestic gas	109.0
Housing - Electricity	57.7	Domestic electricity	47.4
Housing - Oil	51.2	Domestic residual fuels	33.4
Housing - LPG	6.4		
Housing - Biomass	1.1		
Housing - Coal	1.1		
Industrial and commercial - Electricity	88.3	Non-domestic electricity	75.4
Industrial and commercial - Mains gas	46.4	Non-domestic gas	37.9
Industrial and commercial - Other Fuels	37.8	Other fuels non-domestic	52.2
Industrial and commercial - Large industrial consumers	0.0	Large industrial	0.0
Power generation	0.7		
Agriculture - Fuel	20.3	Agriculture	20.9
Agriculture - Livestock and crop-related emissions	65.9		
Aviation	75.3		
Shipping	30.0		
Diesel fuelled railways	1.9	Diesel railways	1.8
F-gases	29.8		
Road Transport	482.4	Road transport	450.6
Waste management	2.6		
Other Transport	29.7	Transport other	2.6
Land use, land-use change, and forestry	-49.1	LULUCF	-49.3
Total	**1084.5**		**781.9**
Total of CSE categories with BEIS equivalent	880.3		

The total of CSE territorial emissions is significantly larger than the BEIS total but when the categories not included by BEIS (notably aviation, shipping and livestock and crop related emissions) are removed they are much more comparable – 880.3 $ktCO_2e$ vs 779.2 $ktCO_2$ (Table 12).

In practice CSE assigns all household emissions identically within each category (territorial and consumption). Table 13 shows the consumption emissions reported by CSE for Winchester District.

Table 13. CSE modelled consumption emissions for the Winchester District.

CSE category	**ktCO_2e**
Consumption of goods and services - Use of services	84.13
Consumption of goods and services - Other consumption related emissions	72.75
Food and diet - Meat and fish	113.20
Food and diet - Other food and drink	100.08
Housing - Mains gas	105.05
Housing - Electricity	57.67
Housing - Oil	51.18
Housing - LPG	6.37
Housing - Biomass	1.11
Housing - Coal	1.09
Travel - Flights	89.31
Travel - Public transport	29.55
Travel - Private transport	113.18
Waste - Waste	2.36
Total	**1018.74**

Part 2. Trends in energy consumption and greenhouse gas emissions in Winchester District 2005-2019

Introduction

Understanding past trends in emissions in a local authority district is the first step to considering what can be done to reduce future emissions. In 2020, BEIS published a report on trends in greenhouse gas emissions in the period 2005-2018 from 382 local authorities in the UK.[23] These emissions included some sources (motorways, some large industrial installations, diesel railways and land use and land use changes and forestry; LULUCF) over which local authorities have no control. Unlike Winchester District, emissions from many local authorities were heavily influenced by activities at industrial sites; changes at a single site can have a big impact on a district's emissions trends. By 2018, see last year's WinACC report[24], the overall reduction of 28.8% in Winchester District's emissions since 2005 was less than that in two-thirds of authorities; 253 authorities (66%) showed reductions of more than 30%.

Table 11 summarises the downward trends in greenhouse gas emissions from different sectors and sub-sectors in Winchester District between 2005 and 2019. Some of the categories differ from previous years because BEIS have altered the way their data are presented. The possible reasons for the decreases in emissions, as well as some changes in energy consumption, in each sector are investigated below.

As is shown later, Winchester District's overall energy consumption decreased steadily from 2005 until 2013 but then it steadily increased until 2018 after which, in 2019, there was a significant decline. The district's overall CO_2 emissions, when emissions from electricity consumption are discounted, declined until around 2011 but have plateaued since then.

Domestic consumption of electricity and gas

Domestic energy consumption (Figures 2- 5) is largely related to the district number of dwellings, population, and household size - estimated to be 2.22 in the private sector and 2.50 overall.[25, 26]

There were 49,494 dwellings in the district in the 2011 census and the ONS estimate there were 49,755 households in 2018, an increase of only 0.53%.[27] Winchester City Council has published forecasts of the number of dwellings based on two scenarios, "natural change" (no net growth of population), and the former South-East housing requirement (now abolished).[28]

The first scenario predicts an increase in dwelling numbers of 4.4% and the second 17.0% in 2021 relative to 2011 (Table 14).

Table 14. Summary of estimated increases in number of households in Winchester District

Year	Est no. of households/ dwellings	Increase ref. 2011 (%)	Source	Scenario	Est. annual increase ref. 2011
2011	49494	0	2011 census		
2018	49755	0.53	ONS		37
2021	51672	4.4	WCC	Natural change	218
2021	57908	17.0	WCC	SE Housing	841

Given the very varied predictions in Table 14 it is difficult to come to any conclusion about the real increase in the number of households until the results of the 2021 census are published. The central figure of 218 per year would indicate an average annual increase of around 0.44%.

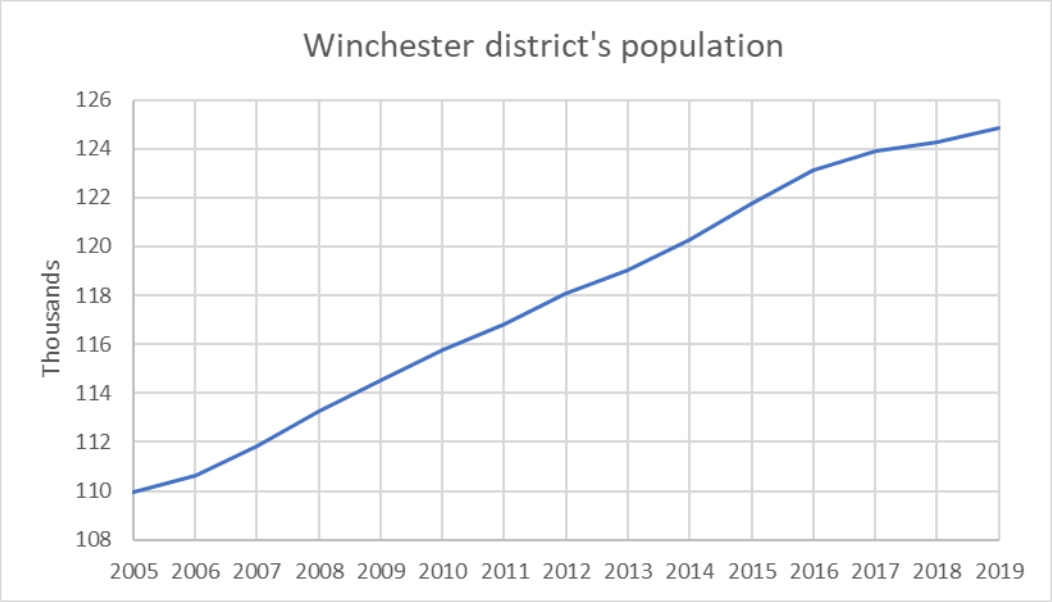


Figure 22. Mid-year population estimates for Winchester District from 2005 to 2019.[29] On average the population grew by 0.9% p.a. over the period. There has been a marked slowing down of population growth since 2016.

The growth in population of Winchester District since 2005 (Figure 22) will have had an important bearing on the consumption of energy and consequently on emissions. As more people live in the district, they create a greater demand for energy which, in turn, will lead to an increase in emissions. It is the absolute amount of CO_2, and other greenhouse gases, emitted into the atmosphere that determines global heating. So we do not present emissions per head.

The increase in the district's population results from people moving into the area - some to live in newly built accommodation (until December 2020 the district had a government-imposed target to build 12,500 dwellings by 2031[30]). The 8.7% increase in the number of households between the censuses in 2001 and 2011 almost exactly matches the 8.9% increase in population in the same period assuming no reduction in the average size of households.[31] The increase is not the result of a trend towards larger families i.e. an increase in the birth rate. Although the actual number of births per year followed an upward trend

from 2005 to 2013 it declined steeply thereafter; further, the annual number of births per 1000 of the population followed a downward trend from 2005 to 2013 and fell even more steeply, by about 10%, between 2013 and 2016.[32]

In summary therefore we know that population has increased around 1% each year and the number of households is estimated to have increased by somewhere between 0.05% and 1.7% each year since 2011. These relatively small annual increases might be expected to have driven up emissions in the last decade or so, yet the combined domestic consumption of both electricity and gas has steadily decreased by ca. 1.3 GWh/year since 2010.

Although household consumption is positively correlated with household size it is not a linear or even a strong relationship. Energy consumption per person decreases as household size increases; single-person households, in particular, have much higher energy consumption per person than larger households. Based on the sizes of Winchester District households in the 2011 census and other information we conclude that in Winchester District a household's emissions from electricity and gas are expected to increase with household size as shown in Table 15.[33,34]

Table 15. Table of estimated increases in relative emissions from electricity and gas with household size

Size of household	**1**	**2**	**3**	**4**	**5**
Relative amount of household emissions	1.00	1.39	1.47	1.57	1.70

It is impossible to identify any single reason for the decrease in the combined domestic consumption of both electricity and gas. Energy prices have increased by 6.9% in the ten years since 2009 for domestic dual fuel consumers obtaining energy from the 'large legacy suppliers' (the big six).[f] Other factors include:

- For electricity: higher efficiency of white goods and electrical appliances of all sorts (especially lighting), greater awareness by homeowners of the need to save energy.
- For gas: a reduction in demand driven by the replacement of inefficient gas boilers by nominally more efficient condensing boilers, and by better insulation of existing and new homes, greater awareness by homeowners of the need to save energy.

Domestic emissions from electricity and gas

Emissions from the use of gas in homes over the last decade or so have followed the same pattern as for the consumption of gas. The reason is that the conversion factor for gas to convert from volume consumed to carbon dioxide output is determined by the chemistry of how gas burns. It is essentially constant.

On the other hand, emissions from the use of electricity have declined significantly since 2013 because of the ongoing national closure of coal-burning and oil-burning power stations and the increasing proportion of low-carbon renewable energy in the national energy mix. Consequently, the conversion factor itself has decreased over time. A very strong correlation between domestic electricity emissions and the conversion factor is illustrated in

[f] https://www.ofgem.gov.uk/data-portal/retail-market-indicators. The prices are apparently not adjusted for inflation.

Figure 23. The difference between the two metrics increased up to almost 16% by 2014 but since 2016 has remained between 9 and 10%. In 2019 domestic emissions 'outperformed' the conversion factor, which decreased by 54.1% between 2005 and 2019, by 9.2%.

Summary of trends

- Electricity consumption has steadily decreased but gas consumption has continued to rise since 2015 which is likely down to an increase in population and households.
- Gas emissions have followed consumption and electricity emissions have fallen as fossil fuel power stations have closed, but more rapidly than expected from the latter factor alone.
  The explanation for domestic electricity emissions outperforming the conversion factor can be attributed to the same factors already listed above.

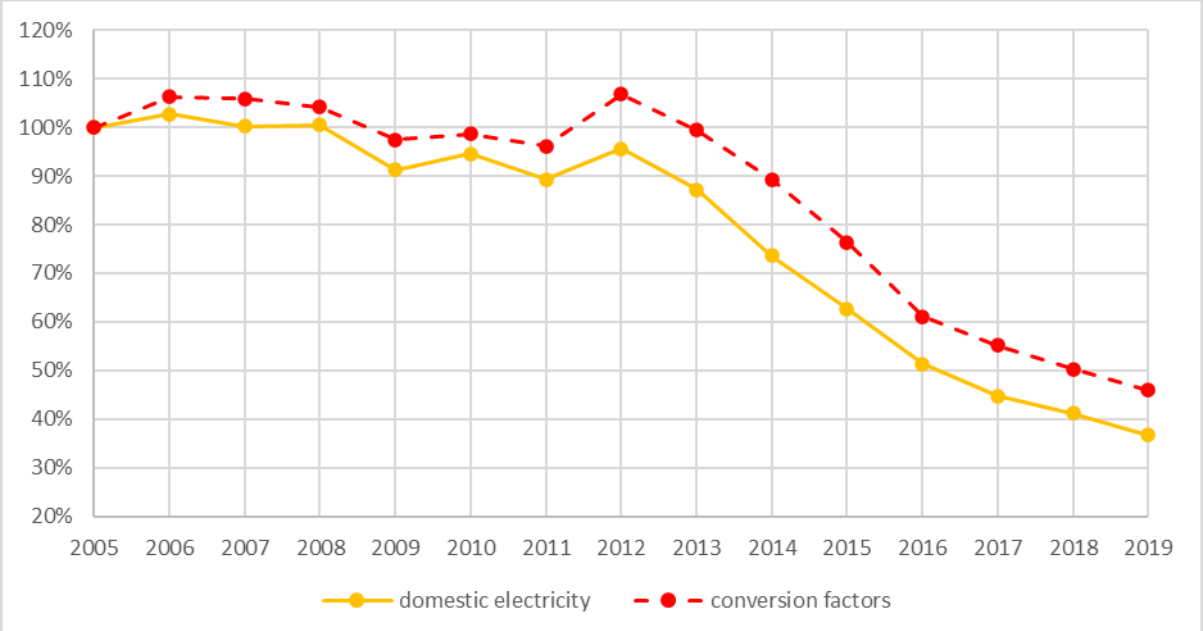


Figure 23. Comparison of domestic emissions with the corresponding conversion factor all relative to 2005. NB. BEIS conversion factors have been adjusted by two years because the BEIS reporting year figure is always two years ahead of the data year.

Non-domestic consumption of electricity and gas

Non-domestic or 'industry and commercial' consumption of electricity and gas is related to the number and sizes of businesses in the district and the nature of the business.

There were almost 7,400 businesses in Winchester District in 2016 covering a huge range of activities.[35] There was a 15% growth in numbers in the 5-year period 2012-2016 and by 2020 the number of businesses had grown to 8,035, roughly 9% more than in 2016.[36]

Only around 1.8% of these businesses employed more than 50 people and as few as 30 businesses employed over 250 between 2016 and 2020. These 30 are presumably some of the largest greenhouse gas emitters. However, it is almost impossible to attribute consumption figures to individual businesses because of commercial-in-confidence considerations.

A common metric for the strength of an economy is called the Gross Value Added (GVA). WinACC assumes that GVA, as well as the number of businesses, has a major bearing on the

emissions from business. GVA increased steadily over the period 2012-2016 by almost 22%. The sectors that contributed the greatest proportions to overall GVA are stated to be 'Distribution; transport; accommodation and food' and 'Public administration; education; health' both of which each provide almost one-fifth of total GVA (19%).[37]

Non-domestic electricity consumption data (Figure 3), formerly presented by BEIS as 'industry and commercial' electricity consumption, decreased overall in the period 2005-2019 by 10.9%. Commercial electricity consumption actually increased up to 2010 but then decreased at least until 2016 before flattening out at around 8% and dropping again in 2019. We cannot explain this behaviour.

Non-domestic gas consumption data (Figure 5), formerly presented by BEIS as 'industry and commercial' gas consumption, have been 'weather corrected' and so any fluctuations are expected to be down to other factors. Consumption decreased almost linearly by 19% between 2006 and 2011 since when it has fluctuated strongly. The biggest changes were an increase, relative to 2006, of almost 13% between 2017 and 2018 followed by a drop of just over 16% in 2019. We cannot explain this behaviour.

Non-domestic emissions from electricity and gas (Figure 11-Figure 14)

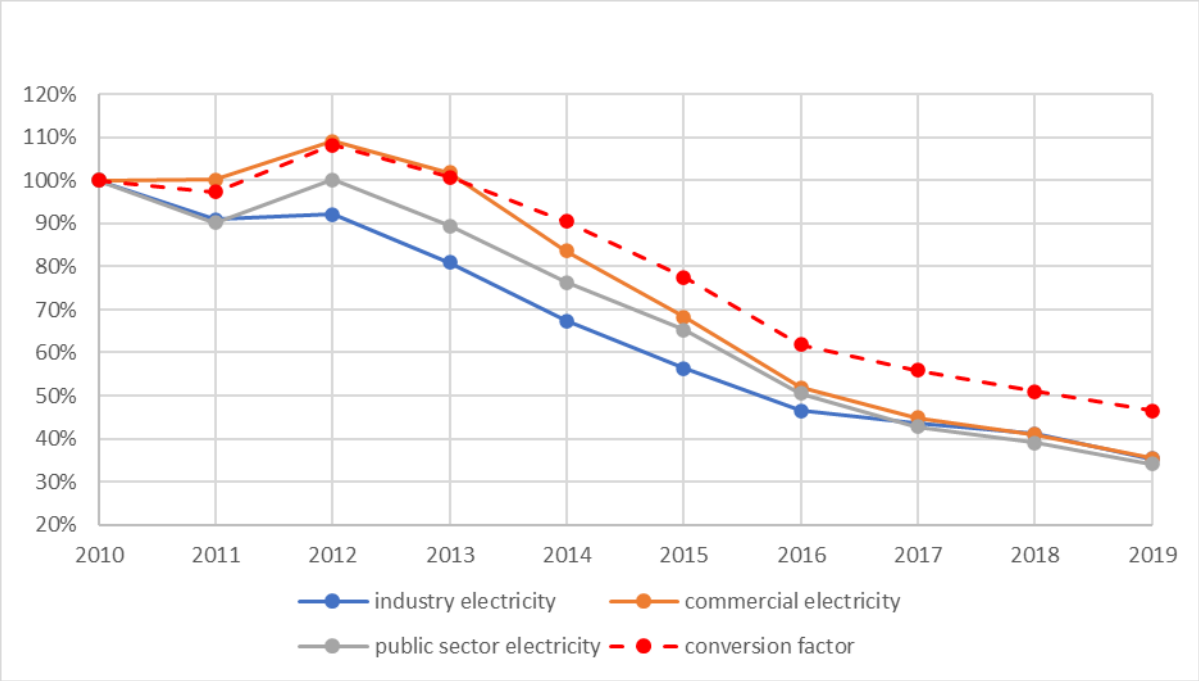


Figure 24. Comparison of non-domestic electricity emissions with the corresponding conversion factor, all relative to 2010 which was the first year for which the split between industry, commercial and public sector emissions was introduced. NB. BEIS conversion factors have been adjusted by two years because the BEIS reporting year figure is always two years ahead of the data year.

As shown in Figure 24 all the non-domestic (industry, commercial and public sector) electricity ***emissions*** started to outperform the fall in the electricity conversion factor between 2011 and 2014. Initially commercial electricity emissions showed no improvement and lagged those from the other two sectors. However, by 2017 all three sectors were outperforming the conversion factor by around 10%. We can only surmise the reasons for this, but they will have included:

- Improved building management systems, especially in the larger businesses
- An increasing realisation of the importance of reducing emissions for climate change reasons and brand/reputation considerations
- The use of more efficient business IT hardware and business systems including moving operations to the cloud which eliminates the requirement for local servers, IT staff and floor space.

The non-domestic (industry, commercial and public sector) gas emissions figures (Figure 14) are particularly hard to interpret because they have not been adjusted for seasonal variations in temperature (weather corrected) and therefore exhibit larger fluctuations.

Public sector emissions

Public sector buildings, a sub-set of the non-domestic sector, provide a particularly good example of sources of CO_2 emissions based on Display Energy Certificates (DECs). They are the only example in the non-domestic sector where energy consumption data is available online. A DEC is a legal requirement for buildings that meet the following criteria:

- The building is at least partially occupied by a public service organisation such as a school, NHS, council or leisure centre
- The occupied area is in excess of 250 m^2
- The building is frequently visited by members of the public

DECs are valid for one year for buildings with a total useful floor area of more than 1,000 m^2. They last for 10 years when the floor area is between 250 and 1,000 m^2.

As of 31 March 2021, 1273 DECs are listed in the DEC database for Winchester District for 157 buildings inspected since 1 January 2011.[g] Only some of these, with floor areas in excess of 1000 m^2, are listed as having been inspected in the previous two years. The sum of all the 'latest' emissions from each building in the database depends on the definition of 'latest' because some DECs are out of date and others are still valid but up to ten years old. For example, the 29 buildings inspected since 1 January 2019 account for emissions of 4.8 $ktCO_2$ whereas the BEIS total for the public sector was 27.2 $ktCO_2$ in 2019.

As an example of what information this source can provide the DECs of 26 state schools were analysed. We chose $kgCO_2$ per square metre of floor space per year as the metric to use for making comparisons and plotted these values for each school with at least two DECs since the beginning of 2011 (Figure 25). The DECs report that all schools used mains gas as their main heating fuel.

[g] However, the Ministry of Housing, Communities & Local Government web site warns that the data "… should not be relied upon to check …. if a DEC has been produced for a public authority building over a certain size." https://epc.opendatacommunities.org/

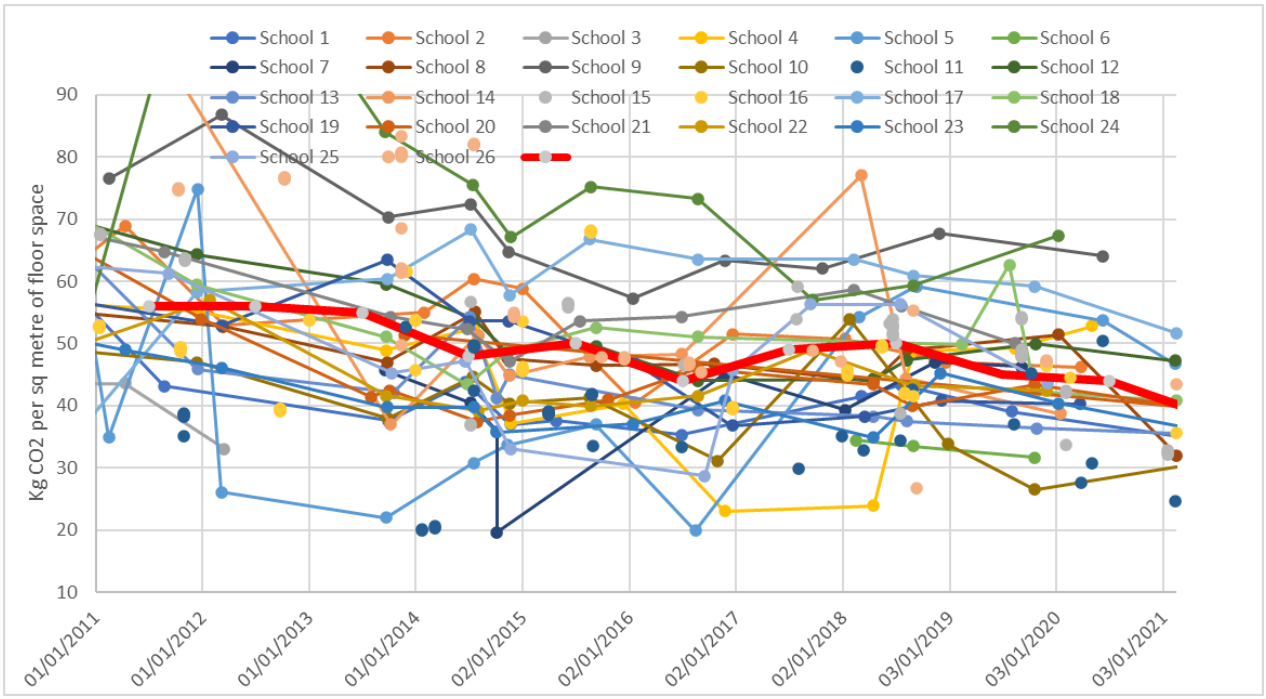


Figure 25. A plot of emissions per unit floor area for state schools in Winchester District since the beginning of 2011 based on published DECs. The data have been anonymised to protect the schools' identity. Where DECs have been issued for more than one building in a school the values are represented by unconnected dots on the graph. Annual averages are connected by the thick red line.

The figure reveals two important facts. First, some schools exhibit large and apparently inconsistent interannual variations and second, there is a weak tendency for the emissions metric to decrease with time although there is a scatter by a factor of almost three in the latest values. The interannual variations suggest that some DECs may contain unreliable data. The potential savings in emissions that might be made by 2030 are relatively small. For example, if all schools were able to reduce their emissions to only 30 kg CO_2/m^2 per year by 2030 there would be a saving of 1034 tonnes relative to the latest figures.[h] The average emissions per floor area for all the most recent school building certificates in the district are 38 kg CO_2/m^2 per year.

Another class of public buildings with substantial emissions is colleges. Sparsholt College, situated in a rural location, uses oil and LPG to heat its buildings and the annual emissions from the latest inspections add up to 1.6 $ktCO_2$. In the last year of inspection, emissions intensity ranged from 57 to 95 kg CO_2/m^2 more than any state school in the district in 2021. Peter Symonds College, a large 6th Form college in Winchester, has buildings mainly heated by natural gas or, in a few cases, by electricity. The annual emissions from the latest inspections add up to 1.1 $ktCO_2$. In the last year of inspection emissions intensity ranged from 19 to 71 $kgCO_2/m^2$ with a single building reaching 148 $kgCO_2/m^2$!

Summary of trends

[h] 30 kg CO_2/m^2 corresponds to a whopping 163 kWh/m^2 for gas alone and 120 kWh/m^2 for electricity. It is worth noting that within Europe the Passivhaus standard requires at most 15 kWh/m^2 for space heating demand. https://www.passivhaustrust.org.uk/what_is_passivhaus.php#2

- There is a distinct lack of publicly available energy consumption or emissions data from almost the whole of the non-domestic sector even though it contributes over one fifth of the district's total emissions.
- Non-domestic electricity emissions have outperformed the decrease in the electricity conversion factor in all three sub-sectors since 2013 but, lacking consumption statistics, we cannot offer an explanation for this.
- Although there has been a slight downward trend in non-domestic gas consumption, modulated by weather, because we lack consumption statistics we cannot offer an explanation for this.
- Based on the latest DECs since 1 January 2015 (2011) public sector buildings had total emissions of just under 13 (18) $ktCO_2$ representing 47% (66%) of emissions from the public sector.
- DECs from state schools show evidence of containing poor quality data. DECs from two colleges are more consistent but they can have even higher emissions per floor area than schools.

Road vehicle fuel consumption

Annual road fuel consumption in Winchester District (Figure 15) depends on several factors. They are principally the number of registered vehicles, the efficiency of the engines (miles per gallon or mpg), and the total distance driven. For a given fuel, mpg translates directly into emissions of CO_2 per mile driven. Given the last statement and the fact that BEIS only assign road traffic emissions to three classes of roads, and not to vehicle types, this discussion is confined to road fuel *consumption*.

Interesting trends appear when the road vehicle consumption statistics are broken down into different vehicle types (Figure 7). Consumption by petrol cars declined steadily between 2005 and 2019. Although they had been the largest consumers of fuel until 2015, by that year they had been overtaken by the steadily increasing consumption by diesel cars. Petrol car consumption dropped by 39% between 2005 and 2019 whereas diesel car consumption increased by 79% up to 2017 after which it declined by 10% two years later. Overall, the total fuel consumption by all cars had dropped by only 7.6% in 2019.

The UK government introduced tax measures which favoured more fuel-efficient diesel cars over petrol cars in 2001 at a time when the health impact of non-CO_2 emissions from cars was not fully realised.[38] Further, it was only from 2014 that it was realised that many diesel cars had been fitted with 'defeat devices' which led to falsified emissions tests. In recent years the true impact on emissions and health of diesel cars has been realised by the public and this likely explains the drop in diesel fuel consumption in Winchester District since 2017 (Figure 26).

For comparison, Figure 26 also shows the relative numbers of the two main types of car engine for each year relative to 2009.[i] In both cases the relative number of cars was always greater than the relative fuel consumption, 17.5% for diesel cars and 27.3% for petrol cars, as engines became more efficient and mpg increased. Nevertheless, there were 61% more petrol cars on Winchester's roads in 2019 than diesel cars.[39]

[i] Electric cars are omitted here. By the end of 2019 there were only 745 electric cars registered in Winchester district (DfT, Table VEH0132a) which was about 1% of all cars.

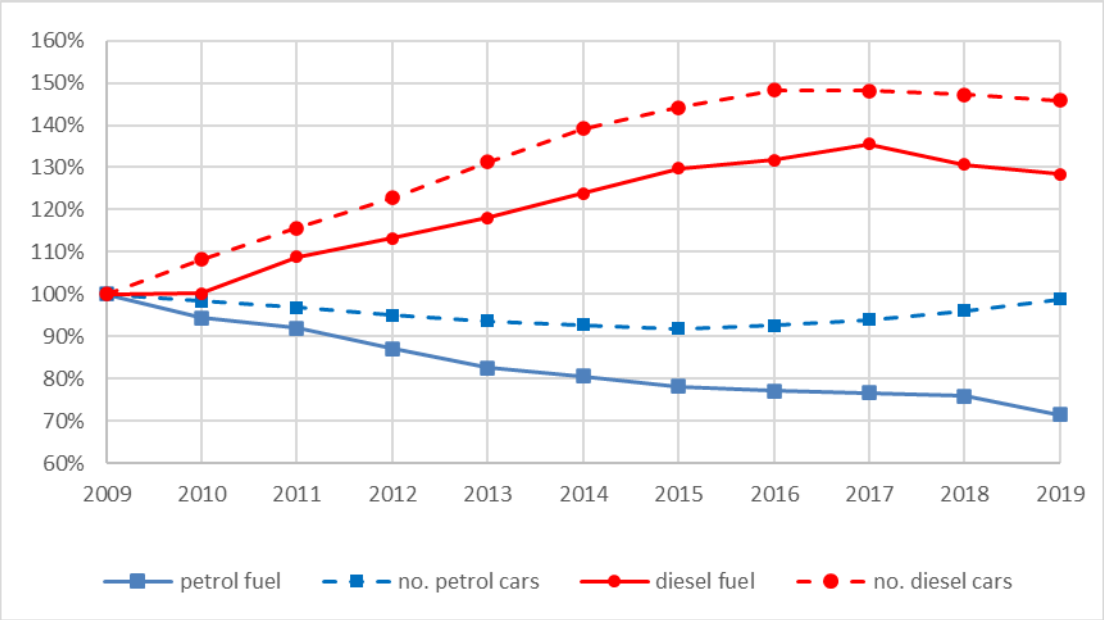


Figure 26. Relative trends in car fuel consumption[40] and numbers of cars[41] in Winchester District from 2009 until 2019.

In partial explanation of the figure the RAC notes that "The UK's average new car fuel consumption in 2019 was 49.2 miles-per-gallon (mpg) for petrol vehicles and 55.4 mpg for diesel vehicles. Average mpg figures for petrol cars were 3 per cent down on the 2018 figure and 4 per cent down for diesel cars."[42] Although huge improvements in average mpg figures have been made since 1997 (45% greater mpg for petrol and 38% for diesel cars) the small reduction in average mpg since 2018 is concerning.

Simple observation suggests, at least in Winchester District, that such a change could be explained by an increase in the number of SUVs which consume more fuel than smaller cars because they are larger, heavier and presumably have more aerodynamic drag. For example, a commonly seen SUV is the diesel Land Rover Discovery 3.0 SDV6 (26.3 mpg when tested in the 'real world') with around half to three-quarters the mpg of a medium-sized car.[43] Further, such mpg effects do not include the much larger carbon emissions attributable to SUVs in their manufacture (more energy, steel, rubber, copper wire, plastic etc. required).

SUVs in Winchester are part of a wider problem. SUVs make up more than 40% of new cars sold in the UK – while fully electric vehicles account for less than 2%.[44] 74% of sales of SUVs in the UK since 2018, which might have been justified for some rural buyers, were actually registered to urban buyers.[45] The International Energy Agency has calculated that the luxury car market for SUVs was the biggest driver of carbon emissions growth from 2010 to 2018 after the power sector. In 2018 almost half of new cars sold in the USA and a third in the EU were SUVs. SUVs were responsible for all of the 3.3 million barrels a day growth in oil demand from passenger cars between 2010 and 2018.[46]

Finally, we can consider the miles driven by different road vehicles in Hampshire (figures for Winchester District are not available online). Hampshire cars drove 8,217 million miles in 2019 far in excess of the 1,979 million miles driven by light and heavy goods vehicles. On the other hand LGV mileage rose by an astonishing 35% between 2009 and 2019 compared to only 10% for cars.

Although fuel consumption of cars exceeded that of goods vehicles in 2019 by 64%, and consumption of both vehicle types declined between 2018 and 2019, there had been a concerning growth between 2013 and 2018 of 23% in the number of diesel LGVs (vans), and 16.3% in their emissions. This is widely attributed to the continued growth in deliveries generated by online shopping even before the impact of the pandemic in 2020.

Summary of trends

- Road fuel emissions fluctuated since 2005 and ended up only 12.2% less by 2019. By 2019 emissions from non-motorway traffic had declined by only 6.8% compared to around 20% for motorway traffic. Nevertheless, traffic remains the largest single source of emissions in the district.
- The combined fuel consumption of petrol and diesel cars had declined by 7.6% by 2019. Although the number of petrol cars was almost unchanged diesel cars had increased in numbers by 45%.
- SUVs are likely to have made a major contribution to road transport emissions, or at least to the increase in emissions, in Winchester District in 2019.
- There has been a strong growth in emissions from diesel LGVs (vans) since 2012 (29% mileage driven, 30% vehicles, 16% fuel consumption) probably the result of more home deliveries. This was halted between 2018 and 2019 when fuel consumption from other principal vehicle classes actually declined.
- Road fuel consumption (and emissions) have been, and remain, susceptible to external influences such as road tax changes and the public's perception of the social acceptability of diesel cars and SUVs.

Consumption and emissions from residual fuels

BEIS presents residual fuel consumption for eleven sectors, six cover petroleum, two each cover coal and manufactured solid fuels plus bioenergy & waste (Figure 16 and Figure 17). Only industrial petroleum, domestic petroleum, agricultural petroleum and bioenergy & wastes are estimated to have consumed more than 4,000 toe in 2018. The other seven sectors each contributed less than 1,000 toe, about 2-4 $ktCO_2$, and, except for coal, are omitted here from further discussion.

It appears that, without more information, limited reliance can be put on this dataset since it is based on the modelled disaggregation of national statistics. Indeed, BEIS advise users of this data "… to recognise the limitations of the information contained in the datasets as they are based on modelled rather than real data, and as such are subject to potential modelling error." We make the following observations.

- Without further information on the energy demand of individual businesses in the district it is hard to explain trends in the consumption of **industrial petroleum**. Consumption evidently declined between 2005 and 2013 and then increased again. A peak in 2010 may be explicable by the cold winter of 2010/2011.[47]
- There has been a fairly steady decline since 2005, excepting peaks in 2010 and 2013, in the consumption of **domestic petroleum**, which is assumed to be principally heating oil and LPG. The two peaks probably reflect the cold winter of 2010/2011 and the cold spring of 2013.[48] This reflects a national decline in the use of energy for

domestic heating since 2005 presumably driven by improvements in the insulation of homes and the efficiency of boilers.

- The consumption of **agricultural petroleum** fuel for tractors and other machinery has remained between 4 and 4.5 ktoe since 2005. This is consistent with an increase of less than 10% in Total Factor Productivity, a measure of the economic performance of agriculture, since 2005.[49] Simple observation suggests that any increases in the efficiency of farm machinery may have been offset by increases in their size and weight and therefore their fuel consumption.
- The consumption of **bioenergy**, mainly for heating, and **wastes** steadily increased from 2005 until 2013 but more slowly in recent years. Although nationally an increase in waste consumption might reflect a trend for UK municipal solid waste to be diverted from landfill to energy recovery facilities, where it is burned to produce electricity, there is no such facility in the district.[j]

Coal consumption appears to include domestic coal and commercial coal as well as coal used by heritage railways. Total coal consumption peaked at 2.91 ktoe in the cold winter of 2010/2011 and then again at 3.27 ktoe in the cold spring of 2013 but has steadily declined since then. It is now illegal to sell bagged house coal in England and selling loose coal will become illegal from 1 May 2023.

Only four sources - industry, commercial, public sector and domestic- appear in BEIS's listings of emissions from residual fuels. Agricultural emissions, previously included in the consumption figures for residual fuels, are listed separately. Commercial emissions from the district have been less than 2ktCO_2 and public sector emissions have been consistently less than 0.7 ktCO_2 since 2015. The trend of emissions from domestic residual fuels was steadily downwards until 2014, except for peaks in 2010 and 2013 (already attributed to cold weather) but has remained flat since then. Industry residual fuels did initially follow a downward trend until 2013 but have steadily risen since then.

As previously mentioned, agriculture consumption has remained almost unchanged since 2007, except for an unexplained dip of about 6% in 2013 (caused by reduced activity in the cold spring of 2013?), and the same pattern is seen in the emissions.

Summary

We cannot draw any useful conclusions from this modelled and uncertain dataset.

Land use and land use changes (LULUCF)

Modelling LULUCF over many years shows a net effect in Winchester District of a steady increase in the removal of greenhouse gases from the atmosphere. In other words, the net impact of the land and its vegetation has been to act as a carbon sink. In 2005 they removed 31.0 ktCO_2 from the atmosphere; this had increased to 49.3 ktCO_2, around 6% of the district's total emissions, by 2019.

The modelling considers 26 categories, but in the district only four of these, as listed by BEIS, exceed 0.1 ktC (0.37 ktCO_2) per year.[50] These four categories act as sources (Cropland

[j] Most of the non-recyclable waste collected from homes in Hampshire is taken to one of three Energy Recovery Facilities located in Marchwood, Chineham and Portsmouth. https://www.hants.gov.uk/wasteandrecycling/whattodowithwaste/yourwaste

and Settlements) and sinks (Forest Land and Grassland). The greatest impact in 2019 came from forest land and grassland acting as sinks (57.1 $ktCO_2$ and 33.1 $ktCO_2$ respectively) which were counteracted by emissions from cropland and settlements (20.6 and 20.3 $ktCO_2$, respectively).

Summary of trends

- Overall LULUCF has made, and is likely to continue to make, a significant contribution to reducing the district's emissions.
- Therefore, planning decisions should take account of the potential impact on the district's emissions of increasing the area occupied by housing (settlements).
- Forests and grasslands should always be protected.
- Farmers should be made aware, if they are not already, of the importance of managing fields used for crops (cropland) in a way that minimises their carbon emissions.

Summary of trends in energy consumption and emissions in Winchester District

Before considering actions to reduce emissions from the district it is worthwhile looking at the total energy consumption and emissions in the period under consideration.

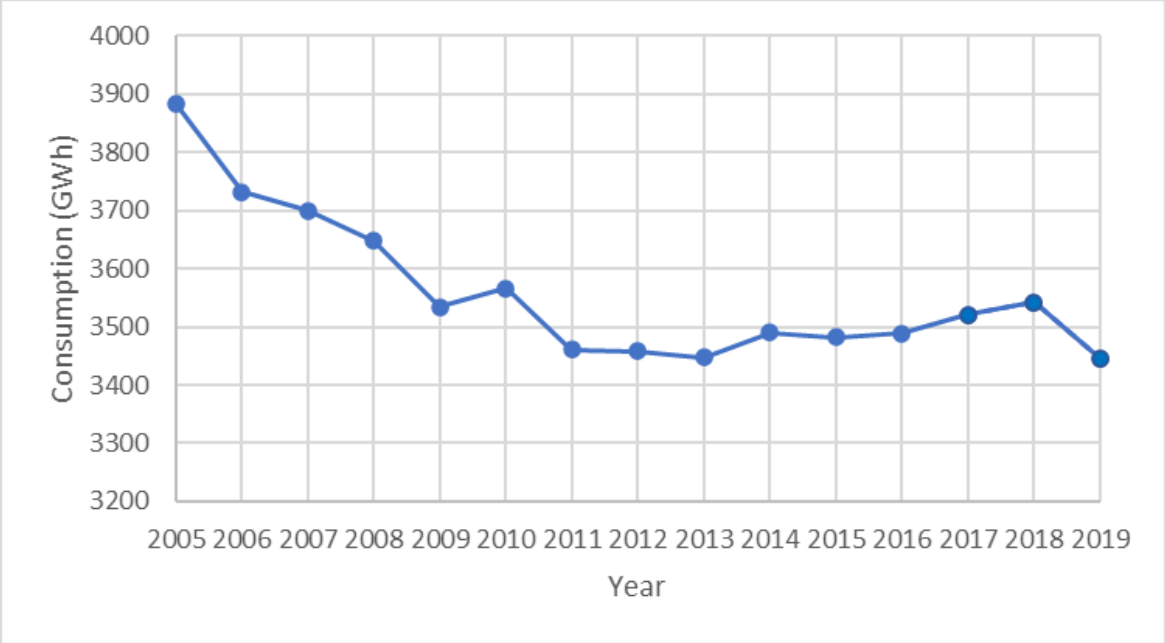


Figure 27. Total direct energy consumption in Winchester District since 2005 expressed in GWh (1 ktoe = 11.63 GWh). Results for residual fuels in 2019 are not yet available so the same value was assumed for residual fuels in 2019 as for 2018.

Figure 27 shows total direct energy consumption in Winchester District since 2005. There was a significant reduction in energy consumption up to 2013 followed by a gradual increase until an inexplicable sharp fall of 95 GWh in 2019.

Only gas consumption might have been influenced by the onset of the COVID-19 pandemic in mid-March 2020 because the actual period of metered gas ended in mid-May 2020. However, it is likely that gas consumption was rapidly decreasing anyway from mid-March until mid-May as the weather improved. Nevertheless, there was an unexplained decrease in commercial gas consumption of 43.5 GWh also accompanied by unexplained decreases in

the consumption of commercial electricity of almost 12 GWh and by a reduction in energy used by cars of 41 GWh, all of which is more than enough to explain the sharp fall (they would have been partly offset by increases from other sectors).

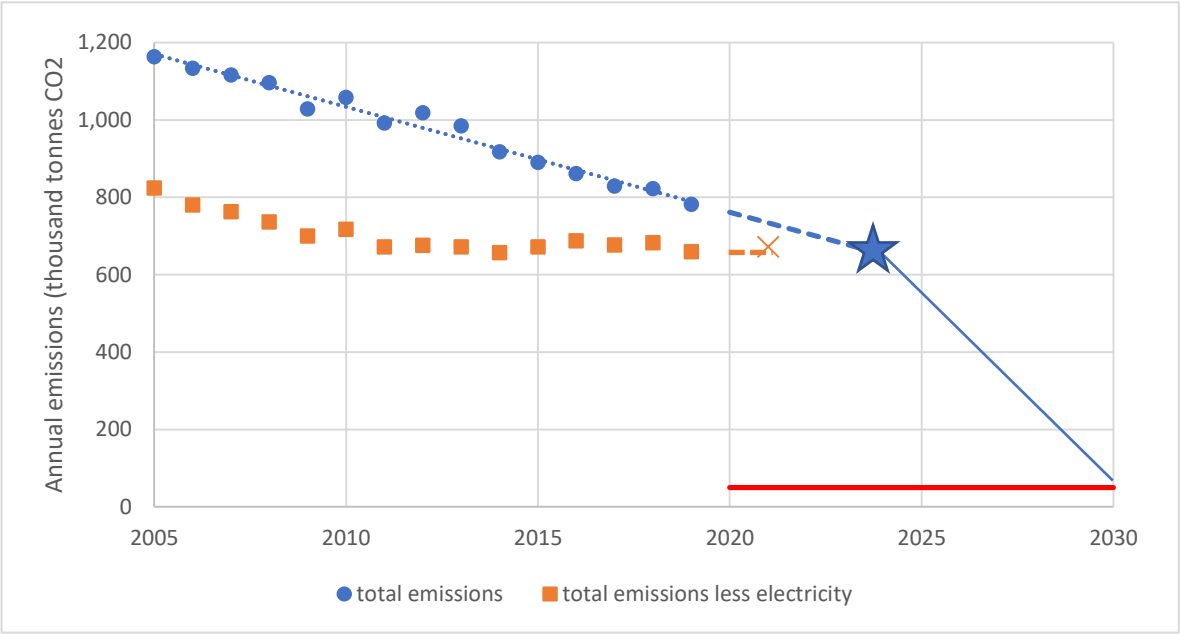


Figure 28. The total direct annual emissions of Winchester District from 2005 up to 2019 on a timescale that ends at 2030 when the City Council intends the district to be carbon neutral. The dots denote total emissions which have been steadily decreasing largely because of the systematic closure of UK fossil-fuel-burning, and especially coal-burning, power stations since 2005. [51] *As a worst case scenario, assuming no reduction in emissions from other sources, the linear total emissions trend has been extrapolated to 2024 when all coal-burning power stations will have been closed (blue star). The squares show a more realistic appraisal, which excludes the emissions from electricity consumption, and suggests that the district's emissions reached a plateau, or at least were no longer declining, around 2014. The plateau has been extrapolated to the end of 2021 (orange cross).The solid blue line indicates that on average a 104 kt CO_2/year reduction is required to achieve net zero by 2030 assuming that non-electricity and LULUCF's negative net emissions of -50 kt CO_2 remain unchanged (red line) to yield a net zero result.*

Figure 28 reveals the impact of the falling energy intensity of electricity generation. Emissions, including electricity, show a steady decline since 2005 as coal and oil-burning power stations have been closed. However, the U.K. will cease all coal-fired electricity generation in October 2024.[52] That being so, and extrapolating the related emissions to the end of 2024, one can predict emissions of around 650 ktCO_2 by then. To reach around zero emissions in 2030 will require a reduction of around 40% per year.

On the other hand, if the contribution from electricity emissions is ignored, *Figure 28* shows that the district's emissions reached a plateau, or at least were no longer declining, around 2014. If cutting emissions from all non-electric sources began in 2022 zero emissions could have been achieved by 2030 but only with a very significant reduction of around 30% per year over ten years.

We now consider what reductions in emissions might be achieved up to the end of 2030 through a variety of actions involving not only the City Council but also HCC, individuals, and homeowners. We shall also consider the possibility of the UK government introducing new legislation and regulations which will affect future emissions from Winchester District.

Part 3. Scenarios for cutting greenhouse gas emissions from Winchester District

Introduction

In June 2019 Winchester City Council (WCC) declared a 'Climate Emergency'. It committed to becoming a carbon neutral council by 2024 and is aiming for the wider district to be carbon neutral by 2030, taking into account both production and consumption emissions.[53] The council equates being carbon neutral with having a net zero carbon footprint. Net zero is usually defined as carbon emissions being no greater than the amount of carbon dioxide which is either sequestered, whether naturally or using some form of technology, or offset. As we have shown, the estimated natural sequestration by LULUCF in 2019 was 49 $ktCO_2$ and by extrapolation is expected to have reached about 65 $ktCO_2$ by 2030. Offsetting is an uncertain and not always reliable means of reducing one's emissions. There are many arguments against offsetting and WinACC sees it only as a last resort.[54]

The Impact tool of the Centre for Sustainable Energy (CSE) presents data on emissions from Winchester District. It includes more sources than BEIS because it includes emissions from food, consumerism and flying. However, the Impact tool offers statistics for a single point in time. So we have no means of projecting or estimating what the emissions from these extra sources will be in 2030. We can only make assumptions about future hard-to-predict reductions in these sectors. There are undoubtedly other sources of emissions, such as from food waste, which we cannot quantify.

Therefore, scenarios to be discussed below relate almost entirely, except for food for which there are estimates of the impact on emissions of making dietary changes, to the BEIS data.

A discussion of how to achieve a carbon neutral Winchester District by 2030 can start from the past or work back from the future.

Starting from emissions at the end of 2021 (predicted by extrapolation from BEIS's 2019 data), and assuming that on average the emissions from a variety of sources are each decreased by a fixed amount each year, it is simple to estimate what the total emissions will be at the end of the nine succeeding years. Approaching the question in this way, assuming the district's direct emissions at the end of 2021 are around 636 $ktCO_2$[k](excluding motorways, Table 11) gives a reduction of 71 $ktCO_2$ per year. However, this approach is only useful if sufficient savings can realistically be made each year. A number of scenarios need to be considered. Even so, the sum of all our efforts may not reach net zero. In that case, we need to focus more strongly on specific, and even different, emissions saving activities.

An alternative approach to the discussion is to work backwards from carbon neutrality in 2030 and determine a constant annual percentage decrease. This approach has the benefit of presenting an unchanging annual target – but this is a target that must be met each year. And that won't happen unless we solve all the unspecified practicalities of how to reach the target.

[k] Allowing for an expected decrease in emissions from the predicted reduction in electricity carbon intensity between 2019 and 2021 of 16 ktCO2.

We think it is more practical to concentrate on the possible decrease in emissions, in $ktCO_2$, by the end of the period 2022-2030, rather than on an annual percentage decrease. We present scenarios to guide future actions. Each scenario has an estimate of total emissions savings made after nine years and is allocated to one of the sub-topics listed in Table 11. The sum of emissions saved by the end of 2030 by all the scenarios can then be subtracted from the estimated annual emissions at the end of 2021 to demonstrate one possible outcome by the end of 2030.

Where practical actions are proposed, such as installing double glazing or changing a central heating system, the calculation for 2030 is straightforward because the change is unlikely to be reversed. Where the action requires a change in behaviour, there is some doubt as to whether that change will persist up to 2030.

We cannot estimate the quantitative emissions savings of some actions, because of a lack of data to base the calculations on. So, in addition, we consider a list of what we have called hard-to-quantify actions for which we propose a simple way to prioritise them.

Lastly, we list new national legislation or changes in regulations that might take effect between now and 2030. These could have a strong impact on building standards or modes of transport, for example. There is great uncertainty in this area because of the lack of leadership and clarity of intent from the UK government.

Quantitative estimates of emissions savings

Simple linear extrapolation of the emissions time series presented in Part 1 is not a reliable way to make quantitative estimates of future emissions even over periods as short as two or three years. Annual sectoral emissions are variable because each sector is exposed to external, and often not easily predicted, factors such as weather, legislation, fuel prices, changes in social norms etc. Fig.20 demonstrates this unpredictability.

In the tables below (Table 16 and Table 17) we show our predictions of savings that could be made by 2030 in a limited number of scenarios. The scenarios are listed according to the sectors and sub-sectors used by BEIS. If a scenario could not be attributed to any single BEIS sector (for example those involving heat saving actions in the home - by improved insulation - because the heat sources were unknown) their savings appear under Unattributable in Table 16, and are itemised separately in Table 17.

Several scenarios had no data available to us to estimate a saving but have been kept in the table as place markers in the hope that relevant local data might eventually be forthcoming.

The scenarios in Table 16 lead to an estimated saving of 191 $ktCO_2$ by the end of 2030. Each scenario, except electricity intensity, usually depends on just one assumed percentage which appears in bold text in the two tables. For a different assumed percentage the change to the saving will be pro rata e.g. if the critical percentage is 50% in a table, say for optimal double glazing, and one wants to assume 25% then half the displayed saving will be obtained.

The results of Table 16 and Table 17 are presented as ranked colour-coded savings of emissions in Figure 29. Because of the lack of data available to us about emissions from industry, commerce or the public sector, other than predictions of the decreasing carbon intensity of electricity, savings in the domestic sector predominate. Figure 29 also shows the importance of road transport which provides five out of the top nine emissions savings.

Changing to a vegetarian diet also makes a big contribution. The sum total (28.7 kt) of improvements to both home insulation and central heating would put this contribution in second place almost tying with working at home.

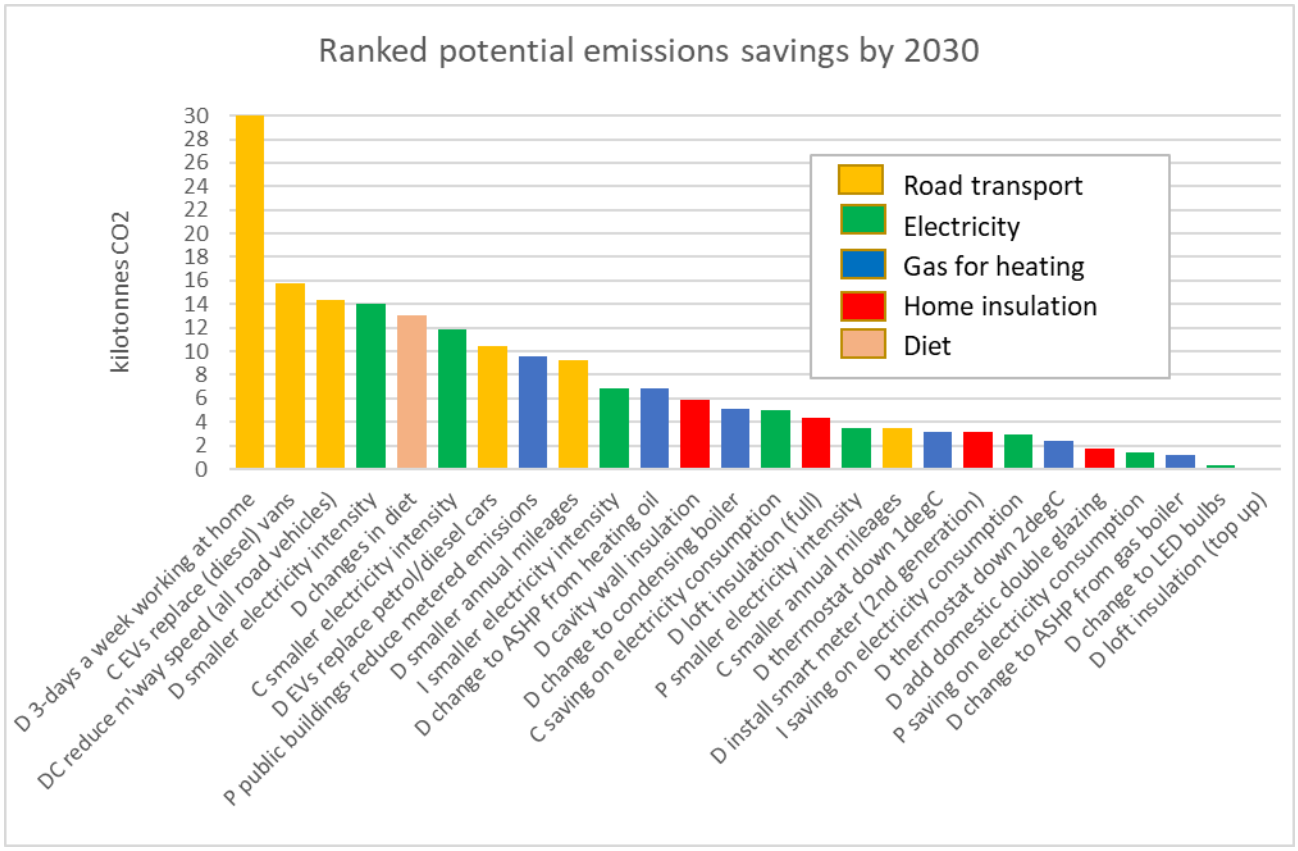


Figure 29. The 26 estimates of emissions savings (ktCO2) by 2030 have been ranked according to the savings. Each saving is colour-coded into one of five areas (see box). The name of each saving on the x-axis is preceded by a letter denoting the BEIS sector to which it belongs (D = domestic; I = industry; C = commerce; P = public sector).

Table 16. A list of quantitative scenarios sorted by sector and sub-sector for saving emissions up to 2030. †Note that, for lack of reliable national data on older models, all calculations for cars and vans assume average emissions of 0.160 kgCO_2/km. BEIS (2021) indicates an average of 0.170 kgCO_2/km for cars and 0.239 for diesel vans..[55]

Sector	Sub-sector	Scenarios	Assumptions made up to the end of 2030 (critical percentages are in bold)	Who does action depend on? (householder, WCC, HCC, UK Government)	Savings by 2030 ($ktCO_2$)	Sub-sector total savings ($ktCO_2$)
Electricity	domestic	smaller electricity intensity	Reduction as per BEIS predictions of kg CO_2/kWh (0.123 in 2022 to 0.079 in 2030 kg CO_2/kWh).	UK Government	14.0	
	domestic	change to LED bulbs	Two-thirds homes have yet to be fully LED. **Another one-third homes** will have all LEDs by 2030 and save on average 15 kg CO_2 p.a. 18,000 (34%) homes have fully converted to LEDs by 2030.	Householder; WCC campaign could influence; UK govt could incentivise	0.3	
						14.3
	industrial	smaller electricity intensity	Reduction as per BEIS predictions of kg CO_2/kWh (0.123 in 2022 to 0.079 in 2030 kg CO_2/kWh).	UK Government	6.9	
	industrial	saving on electricity consumption	Assume overall manufacturing businesses save **33%** of electricity consumption by 2030.	Industry; WCC campaign could influence	2.9	
						9.8
	commercial	smaller electricity intensity	Reduction as per BEIS predictions of kg CO_2/kWh (0.123 in 2022 to 0.079 in 2030 kg CO_2/kWh).	UK Government	11.8	
	commercial	saving on electricity consumption	Assume overall businesses save **33%** of electricity consumption by 2030, e.g. refrigeration.	Business; WCC campaign could influence; UK govt could incentivise	5.0	
						16.8

	public sector	smaller electricity intensity	Reduction as per BEIS predictions of kg CO_2/kWh (0.123 in 2022 to 0.079 in 2030 kg CO_2/kWh).	UK Government	3.5	
	public sector	saving on electricity consumption	Assume public bodies save **33%** of electricity consumption by 2030	Public sector; WCC campaign; UK govt could incentivise	1.5	
						4.9
Gas	domestic	thermostat down 1 °C	**50%** of homes with mains gas (21,093) will have turned down thermostat by 1 °C i.e. 2,344 per year and maintain the change.	Householder; WCC or national campaign could influence	3.1	
	domestic	thermostat down 2 °C	**10%** of private homes (4,000) with full CH will have turned down thermostat by 2 °C and maintain the change.	Householder; WCC or national campaign could influence	2.4	
	domestic	change to condensing boiler	By end of 2029 (last year allowed) 8000 (**90%**) homes with mains gas but not condensing boilers will have changed to condensing boiler each saving 25% gas from then on.	Householder (WCC for Council housing); WCC or national campaign could influence	5.1	
	domestic	optimising condensing boiler settings	Insufficient information to create scenario. Many condensing boilers are known to be set up incorrectly but no data available.			
	domestic	change to ASHP from gas boiler	450 larger homes (**1.1%)** out of 42,186 with mains gas will have ASHPs	Householder (WCC for Council housing); WCC campaign could influence; UK Govt could incentivise	1.2	
	domestic	change to ASHP from heating oil	1800 larger homes (**16%**) out of 8,864 without mains gas will have ASHPs	Householder (WCC for Council housing); WCC campaign could influence; UK Govt could incentivise	6.8	
						18.6
	industrial	no data on which to base a scenario				0.0

	commercial	no data on which to base a scenario				0.0
	public sector	public buildings reduce metered emissions	**157** public buildings improve insulation etc. to reduce emissions to 30 kg CO_2/m2/year	WCC/HCC	9.6	9.6
Road transport†	cars	EVs replace petrol/diesel cars	Predict **5,935** EVs (8.5% of cars in Winchester District in 2019) based on extrapolating licence **numbers** from Q4 2011 to Q4 2020.	WCC campaign/UK Government campaign/incentivise	10.5	
	cars	smaller annual mileages	36,000 cars (**51%**) will have reduced annual mileage by 1000 miles (**13.5%**).	car drivers; WCC can disincentivise by parking charges, road closures; HCC better bus provision	9.2	
	cars	fewer SUVs bought	Insufficient information to create scenario	UK Govt legislation or incentives		
	cars	reduce motorway speed limit (all road vehicles)	Motorway speed limit reduced from **70 mph to 60 mph** (all vehicles) saves **8%** of emissions	UK Government legislation	14.3	
	cars	3-days a week working at home	Reduction in car mileage by working at home **3-days a week** (saves 60% of commute emissions) for half of workers.	UK Government campaign/legislation/incentives. Business/industry changes.	30.1	
	LGV/HGV	EVs replace (diesel) vans	2000 (**20%**) of all vans (100% of delivery vehicles and half of tradesmen vehicles) are electric.	UK Government legislation or incentives	15.8	
	LGV/HGV	smaller annual mileages	9000 vans (**90%**) have reduced their annual mileage of 17,500 by 1500 miles (**9%**).	UK Government legislation or incentives	3.5	
						83.3
Residual fuels	domestic	heating oil to ASHP	already accounted for, see above			0.0
	industrial	no data on which				0.0

		to base a scenario				
	commercial	no data on which to base a scenario				0.0
	public sector	included in public sector gas above				0.0
Agriculture		no data on which to base a scenario				0.0
Miscellaneous transport		no data on which to base a scenario				0.0
Unattributable		See Table 17				28.3
GRAND TOTAL						**191.2**

Table 17. List of emissions saving scenarios that are not easily attributable to any single BEIS sector/sub-sector.

Sector	**Sub-sector**	**Scenarios**	**Assumptions made for end of 2030 (critical percentage in bold)**	**Who does action depend on? Householder, WCC, HCC, UK govt?**	**Savings by 2030 ($ktCO_2$)**	**Sub-sector total savings ($ktCO_2$)**
Unattributable	domestic	add domestic double/triple glazing	Assume **13%** private homes don't have optimal double glazing. By 2030 5,400 more private homes have A-rated double-glazing throughout.	WCC/Government campaigns and/or incentives	1.8	
	domestic	changes in diet	**36%** people change from a 'healthy diet' to vegetarianism thereby reducing food emissions by 22% (Dunne, 2020)	Individuals/WCC campaign	13.1	

	domestic	cavity wall insulation	8,100 more homes (**66%** of homes without) have CW insulation by 2030.	Householder (WCC for Council housing); WCC/Government campaigns and or incentives	5.8	
	domestic	loft insulation (full)	5,220 lofts fully insulated i.e. **69%** with potential for full loft insulation.	WCC/Government campaigns and/or incentives	4.3	
	domestic	loft insulation (top up)	2,025 lofts topped up i.e. **69%** with potential for top up loft insulation.	WCC/Government campaigns and/or incentives	0.1	
	domestic	install smart meter (2nd generation)	All homes have smart meters and make a one-off estimated saving of **2%** by 2025.	Government legislation	3.1	
	domestic	draught-proofing homes (hard to quantify)	Insufficient information to create scenario			
TOTAL UNATTRIBUTABLE						**28.3**

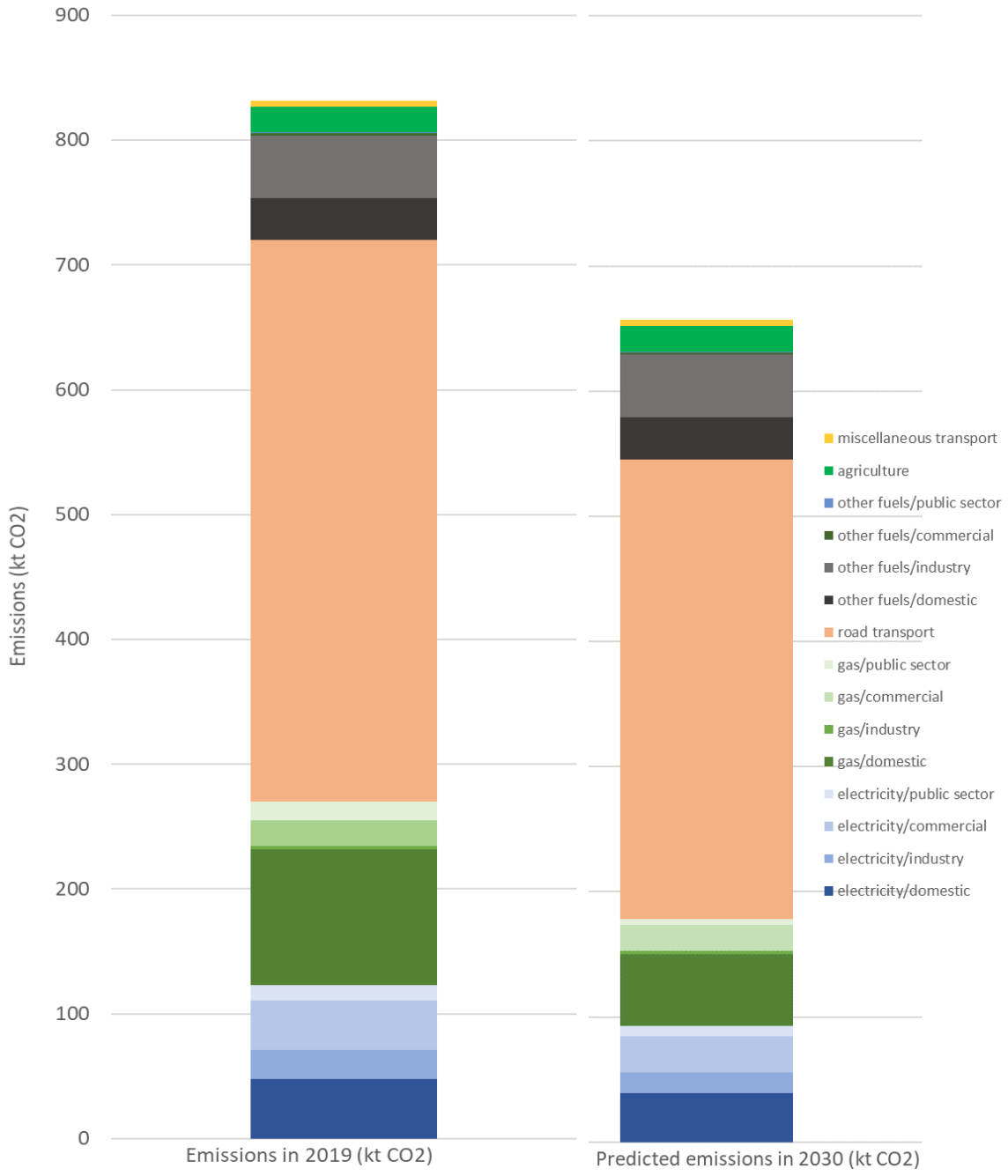


Figure 30. A graphical representation of possible emissions savings in BEIS sectors alone from quantified scenarios (excluding LULUCF changes and Unattributable emissions) by 2030.

Table 18 summarises the net effect on total emissions of the estimated savings by 2030 plus a saving from the net LULUCF sink estimated for the same year by extrapolating from the approximately linear trend seen in Figure 18. LULUCF CO_2 emissions in the Winchester District 2005-2019. Note that some emissions figures including the net total are negative indicating net absorption of CO_2. If motorway emissions are ignored, because they constitute only 40% of road transport emissions of which maybe only 20% come from local traffic, the district's total emissions fall from 636 to 381 $ktCO_2$ which is a drop of 40%. This is shown graphically for the BEIS sectors alone in Figure 30.

Table 18. Estimated changes in emissions ($ktCO_2$) in Winchester District from 2019 to 2030. †The estimated emissions in 2030 before allowing for the LULUCF sink and savings made in 2022-2030 are the same as in 2019 less an estimated 16 $ktCO_2$ saved from the predicted 13% reduction in electricity intensity from 2019 to 2021. Totals that ignore the emissions from motorways are shown in brackets.

Item	2019	2030
Total BEIS emissions (sources)	831.3 (652.4)	815.3 (636.4)†
Estimated savings relative to end 2021	---	-191.2
Net LULUCF (sink)	-49.3	-64.7
Net total emissions	782.0 (603.1)	559.4 (380.5)

The tables of scenarios (Table 16, Table 17) concentrate on savings to be made in the domestic sector including cars. This is largely because of the lack of data on emissions from the non-domestic sectors, whether industry, commercial or public sector, except for public buildings which are partly covered by Display Energy Certificates.

However, areas for further investigation are suggested by the CSE Impact tool data at parish level. For example, the parishes of Durley (15.4 kt) and Curdridge (18.2 kt) exhibit unusually high total commercial emissions, from the consumption of electricity, gas and residual fuels, apparently associated with physical groupings of commercial units (business parks) in those villages. Together these two parishes are apparently responsible for almost a quarter of all the industry and commercial emissions identified by BEIS in the district! Together these two outliers alone are equivalent to 5.6% of the district's total emissions (excluding motorways).

Other hard-to-quantify areas for saving emissions

Table 19 lists a number of hard-to-quantify actions that may lead to emissions savings in Winchester District. Each action has been given a priority which is the product of the estimated financial implication for the City Council, the degree to which the City Council will have control on the outcome and the estimated likely impact on emissions reductions (see Notes in the table). These assignations are qualitative and even subjective but the priorities indicate where follow up actions might be concentrated. (Regarding retrofitting homes and land use there is some overlap with the quantified actions in Tables 16 and 17.) It may be possible for the City Council to quantify the emissions savings from some of the listed actions, such as under Transport, using relevant data that they hold.

Table 19 also includes actions related to renewable sources of energy. We accept that it is difficult to argue that, say, a new photovoltaic solar farm will actually reduce emissions from the district. It will contribute to overall electricity generation on a national scale by feeding into the grid and thereby very slightly reduce the emissions intensity of electricity which then feeds back into the district's own reduction in emissions.[56] Nevertheless, this is clearly an area in which the City Council needs to be active, whether by making investments itself, supporting community energy schemes, or by encouraging planning applications for large-scale renewable developments.

The actions listed in Table 19 have been ranked by their estimated priority in Figure 31 but it must be remembered that the assigned priorities are subjective. Five out of the top seven relate to Finance & Assets. Renewable energy generation gets high rankings as do two road transport actions yet, in contrast to the predicted savings in Table 16 and Table 17, new buildings and retrofitting get low priorities.

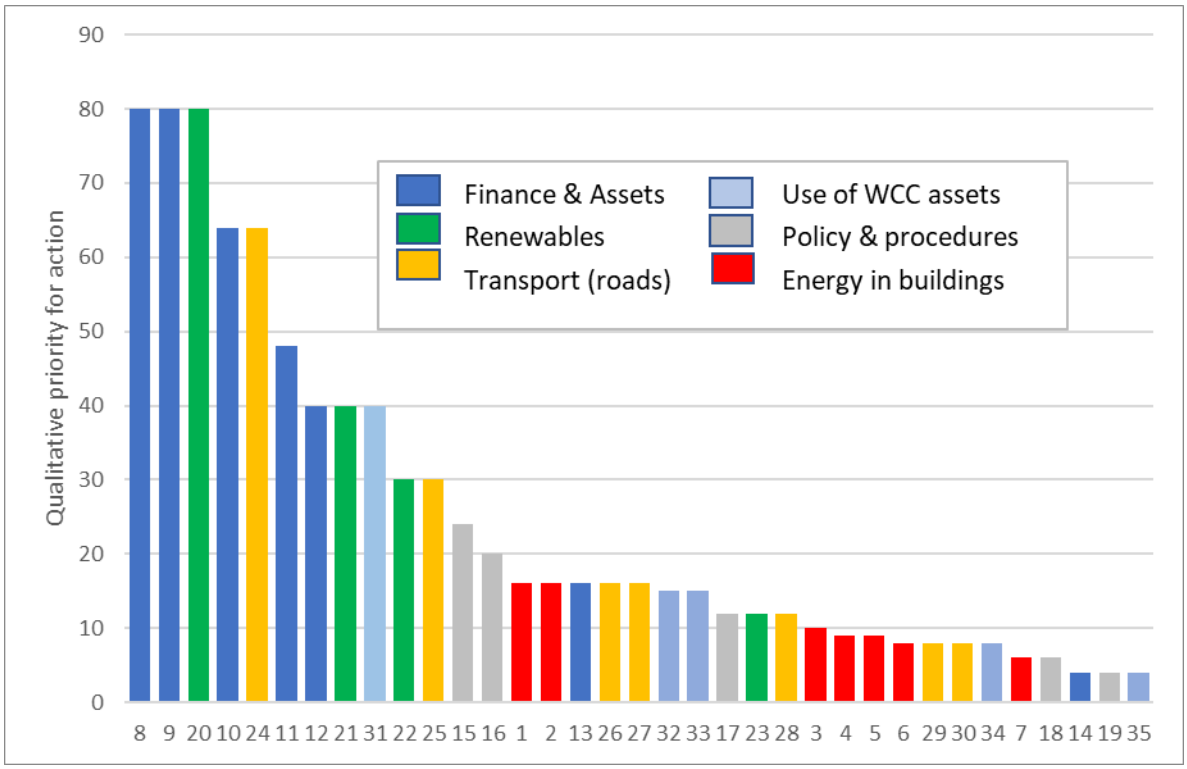


Figure 31. The figure shows 35 actions listed in Table 19 ranked according to their subjectively assigned priorities. Each action is identified on the x-axis by a number which appears in the table. The actions are colour-coded according to the scheme in the box.

Table 19. Hard-to-quantify actions that may cut emissions from Winchester District up to 2030. Action numbers refer to Fig.31.

Sector	Action no.	Action	Priority for action (cost x power x impact)	WCC cost Note 1	WCC power to influence change Note 2	Impact of the outcome (not of WCC action) Note 3	Data source	Assumption
Energy use in buildings - new	1	Set high standards of carbon neutrality for all new buildings in the Local Plan; encourage heat networks for new developments; remove planning restrictions on photovoltaic and thermal roof panels in the Local Plan; encourage higher density on housing developments; allocate development sites in locations that make best use of existing infrastructure and provide primary access by active/public transport.	16	4	4	1	Average domestic emissions per home for home heating is 4.26 tonnes CO_2e (CSE Impact tool). Local Plans Strategies and Priorities	Assume that distribution of new housing mirrors current distribution of on- and off-gas grid and that there will be residual emissions from (e.g.) lighting. Standard Methodology requirement for the district was 692 new dwellings per annum. But some housing has already been completed and a large number of planning consents are in the 'pipeline', totalling about 11,300 dwellings. So the additional housing that the new Local Plan may need is currently 1200 over the 9 years 2022-2030.
Energy use in buildings - new	2	Set development management policies to require (in order of priority): - zero carbon, with penalties where monitoring shows they did not achieve it - fewer emissions than are produced by whatever developments replace - maximising potential for solar power and heat pumps, passive heating and cooling - minimise impermeable hard surfaces.	16	4	4	1		

Energy use in buildings - retrofit	3	Support a programme of deep retrofit for homes to zero carbon standards a) council homes	10	1	5	2	16% (8000) dwellings are social rent (Strategic Housing Market Assessment, Winchester District, by Iceni Projects Limited on behalf ofWCC Feb 2020).	Assume retrofitting can cut emissions by half.
Energy use in buildings - retrofit	4	Support a programme of deep retrofit for homes to zero carbon standards b) privately owned	9	1	3	3	70% (35,000) of dwellings are owner-occupied and 14% (7000) privately rented (ibid above).	Assume retrofitting can cut emissions by half.
Energy use in buildings - retrofit	5	A rolling fund to enable retrofit of private dwellings, including replacing fossil fuel heating with zero-carbon renewable systems	9	3	3	1	50,000 of dwellings in district of which 70% are owner-occupied and 14% privately rented (ibid above)	Assume retrofitting can cut emissions by half, and fund is used by 1 in 50 private owners
Energy use in buildings - retrofit	6	A framework that enables properties listed or in Conservation Areas to be made more energy efficient	8	4	2	1		
Energy use in buildings - retrofit	7	Training for retrofit co-ordinators and tradespeople (partly subsidised?)	6	3	2	1		
Finance & Assets	8	Always apply for national funding	80	5	4	4		
Finance & Assets	9	Invest WCC money in large scale renewables	80	5	4	4		
Finance & Assets	10	Use WCC investments to help achieve carbon neutrality	64	4	4	4		

Finance & Assets	11	Invest WCC money in carbon reduction projects	48	4	4	3		
Finance & Assets	12	Set up Green fund / green bonds	40	5	4	2		
Finance & Assets	13	Press for Hampshire Pension Fund to divest and invest in green businesses	16	4	2	2	Hampshire Pension Fund's fossil fuel investments is £136.1 million (https://gmail.us7.list-manage.com/track/click?u=42808e1164d69c24fa84e74f9&id=48668c46ff&e=fb9f241414 - 23 February 2021)	128 tonnes CO_2 per million pounds invested in its equity or stock holdings (ref. being sought, quoted by deputation to HPF Board Feb 2021). Assumed 60% of fossil fuel investment is in equity or stock holdings (2019 annual report page 32 https://documents.hants.gov.uk/pensions/2019-valuationreport.pdf).
Land use	14	Encourage all landowners to measure their carbon footprint using one of the three UK market leading apps	4	4	1	1		
Policy and procedures	15	Integrate climate crisis measures into the City Council's overall strategy and into all the City Council's strategies and policies	24	4	3	2		
Policy and procedures	16	Lobby central government for support, policy change and funding	20	5	1	4		
Policy and procedures	17	Follow best practice using evidence from leading local authorities to inform Council decisions – educating officers and members about what can be done	12	4	3	1		
Policy and procedures	18	Act with community groups, parishes and business; and involve a representative sample of residents in a process to make informed decisions about priorities and actions, giving legitimacy to the Council's work on the climate emergency	6	3	2	1		

Policy and procedures	19	Emphasise the economic benefit for Winchester of being seen as a leader in planning for adaptations to climate heating that make Winchester District an attractive place to live, work, visit and invest in.	4	4	1	1		
Renewable energy generation	20	Identify sites for large-scale zero-carbon energy production and/or supply in the Local Plan	80	4	4	5		
Renewable energy generation	21	Encourage developers to propose large scale renewable energy schemes - solar	40	5	4	2	Barton Willmore Planning Statement at https://www.winacc.org.uk/what-we-do/campaigns-2/solar-21farm-application-godsfield-lane/.	1 solar farm provides 12 MW saving 3,060 tonnes of CO_2 per annum
Renewable energy generation	22	Encourage developers to propose large scale renewable energy schemes - other e.g. anaerobic digester, wind turbines, waste to power	30	5	3	2	1 anaerobic digester saves 25,000 tonnes CO_2 a year (WinACC)	Unless public opinion shifts, we are likely to get no more than 3 digesters, no wind farms, 3 battery storage units, maybe 1 waste-to-power
Renewable energy generation	23	Support communities to create their own renewable energy schemes	12	3	4	1		Mostly solar PV on roofs or small spaces in c. 25% of parishes
Transport	24	WCC to reduce private vehicle traffic (within remit) including:	64	4	4	4	CSE Impact tool	30% travel emissions are in Winchester city
Transport	25	A congestion charge		5	4			
Transport	26	Clean Air Zones, with charging		5	4			
Transport	27	Close all public car parks within the old city walls		3	5			
Transport	28	Treble charges for residents' and visitors' on-street parking permits		5	5			

Transport	29	Implement a workplace parking levy		5	5			
Transport	30	Revise car parking standards for new dwellings and at change of occupant (number and type of car fuel)		4	5			
Transport	31	Energise support for the new Local Transport Plan (LPT4) to prioritise creating zero carbon transport	30	3	2	5	CSE Impact tool	LTP4 reduces travel emissions by 50% (except M3)
Transport	32	Require all transport schemes to identify the impact on greenhouse gas emissions	16	4	2	2		
Transport	33	Oppose transport schemes which increase emissions, and aim for carbon reduction	16	4	2	2		
Transport	34	Press HCC to allocate a much larger share of its transport funding for schemes for pedestrians, cycling, or public transport including rail transport	12	4	1	3		
Transport	35	Publicise the support for low carbon travel from both national government and voters	8	4	2	1		
Transport	36	Set a timetable with milestones and penalty clauses for the County Council to do everything in its remit as transport authority to implement the Winchester Movement Strategy at once – and encourage them to go further	8	4	2	1		
Use of WCC assets	37	Prioritising CIL and S106 money to carbon reduction uses	40	4	5	2		
Use of WCC assets	38	Solar panels on Council land and buildings	15	3	5	1		This excludes housing; includes car parks, offices, depots
Use of WCC assets	39	Using all Council land for allotments or minimal intervention	15	5	3	1		It is impossible to give even a guesstimate unless one knows what the land is currently used for and whether its future use is to grow food or to leave wild.

Use of WCC assets	40	Make low carbon, both embodied and in use, the key decision-factor in all procurement	8	4	2	1		
Use of WCC assets	41	"Preston Model" approach to climate change spending- collaborate	4	4	1	1		

Notes:

1. Col. 5. 5= generates income or cuts costs to WCC; 4= almost zero cost to WCC; 3= small to medium cost to WCC; 2= medium to large cost to WCC; 1 = substantial cost to WCC
2. Col. 6. 5 = outcome is in WCC power; 4= WCC action makes emission reduction much more likely; 3= WCC action makes emission reduction more likely; 2= WCC action makes emission reduction a bit more likely; 1= WCC influence too small to measure
3. Col. 7. 5= highest impact on emissions to 1=lowest impact

Possible external factors that may affect Winchester's emissions before 2030

The scenarios listed in Table 16 deliver emissions savings that take the district only partly along the route to net zero by 2030. This demonstrates that individuals, households and even businesses can only deliver so much. A lot more would be possible if supported or determined by national legislation whether covering England or the whole UK.

It is frequently said that such legislation is being prepared or is in the pipeline. Therefore, a summary of relevant and recently announced parliamentary bills, new regulations and consultations follows in Table 20 with our judgement of their likely eventual qualitative impact on emissions from Winchester District. It is too early to make a quantitative estimate of their impact by 2030.

Several other ideas and a private members' bill have been mooted in the recent past but are judged to be unlikely to affect emissions in Winchester District at least before 2030. They include the Climate and Ecological Emergency Bill, the imposition of a frequent flyer levy, the introduction of free public transport and a reduction in building new roads or improving existing roads.

Table 20. Likely and Possible UK government future legislation, regulations and other changes that might affect carbon emissions from Winchester District before 2030.

Bill, regulation or funding source	Expected date in force	Status	Relevant impacts	Source
LIKELY				
Environment Bill	Autumn 2021	Report stage, House of Lords	Peat compost banned, more tree planting, better re-cycling, less plastic waste	www.bigissue.com/latest/environment/environment-bill-what-is-it-what-laws-will-be-in-it-and-when-to-expect-it/
New Building Regulations, updates to Parts F and L. Future Homes Standard.	Consultation started January 2021; FHS in 2025	Ongoing	High energy efficiency in new builds and retrofitted homes	www.c80solutions.co.uk/7-things-you-need-to-know-about-the-governments-latest-future-homes-standard-announcement/
Planning Bill		'*Planning for the Future'* white paper. A separate consultation closed October 2020.	Uncertain, hard to translate into emissions savings	commonslibrary.parliament.uk/research-briefings/cbp-8981/
'Bus Back Better' and Bus Service Improvement Plans	April 2022	Department for Transport report in March 2021	More public transport, if it happens, could reduce car emissions	www.gov.uk/government/publications/bus-back-bette r
Funds for Active Travel	Tranche 1 over, tranches 2 & 3 extant	Future funding allocations to be decided	Walking and cycling can displace car journeys; health benefits.	www.gov.uk/government/publications/emergency-active-travel-fund-local-transport-authority-allocations
Great British Railways	Two year 'bridge to reform' underway	New GBR public body unveiled May 2021	'Great British Railways to integrate the railways and deliver passenger-focused travel with simpler, modern fares and reliable services.' Faster rail journeys could displace car journeys.	www.gov.uk/government/news/great-british-railways-for-the-passenger

'Last mile' deliveries	Already happening independently of government	Some companies are investing in fleets of EVs and e-cargo bikes for local deliveries	Reduces tailpipe emissions; co-benefits to health from less air pollution in urban areas e.g. Oxford, SE London, Banavie nr. Fort William.	energysavingtrust.org.uk/sites/default/files/EST007-01-EST%2BDFT-Electrifying%20last%20mile%20deliveries%20guide-WEB.pdf
POSSIBLE				
Heat and Buildings Strategy	September 2021?	Delayed within government. Will build on pledges made in the government's '*10 Point Plan for a Green Industrial Revolution'*, and the '*Energy White Paper*'	Will reduce emissions from homes and businesses by banning gas boilers and ramping up heat pump installations.	www.homebuilding.co.uk/advice/heat-and-buildings-strategy
Road vehicle taxes	??	Nothing known	A re-vamp of Road Fund Licences could lead to fewer, most polluting vehicles such as SUVs.	

The spatial distribution of emissions within Winchester District

It is easy to forget that CO_2 emissions are not evenly distributed throughout the district. For example, CSE's Impact tool shows that only 29% of consumption emissions come from the five wards of Winchester city which is home to around one third of the district's population. Although there are no major point sources of emissions in the district, maps published by the National Atmospheric Emissions Inventory (NAEI) on a 1x1 km grid give some sense of the spatial distribution of emissions.[57] The maps display emissions of 'carbon dioxide as carbon' and clearly demonstrate the importance of motorways (M3 and M27) and main roads (A31, A32 and A34) as linear sources (Figure 32).

The largest emissions in the district (which emit over 1.995 kt C/km2), which come from 'non-industrial combustion plants', are concentrated within just two grid cells covering central Winchester (Fig. 33). Together these two cells covering 0.3% of the district's area account for at least 5% of the district's emissions. This category includes emissions from gas central heating boilers. Other significant sources (up to 1.995 kt C/km2) from within the district come from 'combustion in manufacturing industry' and 'other mobile sources and machinery'.

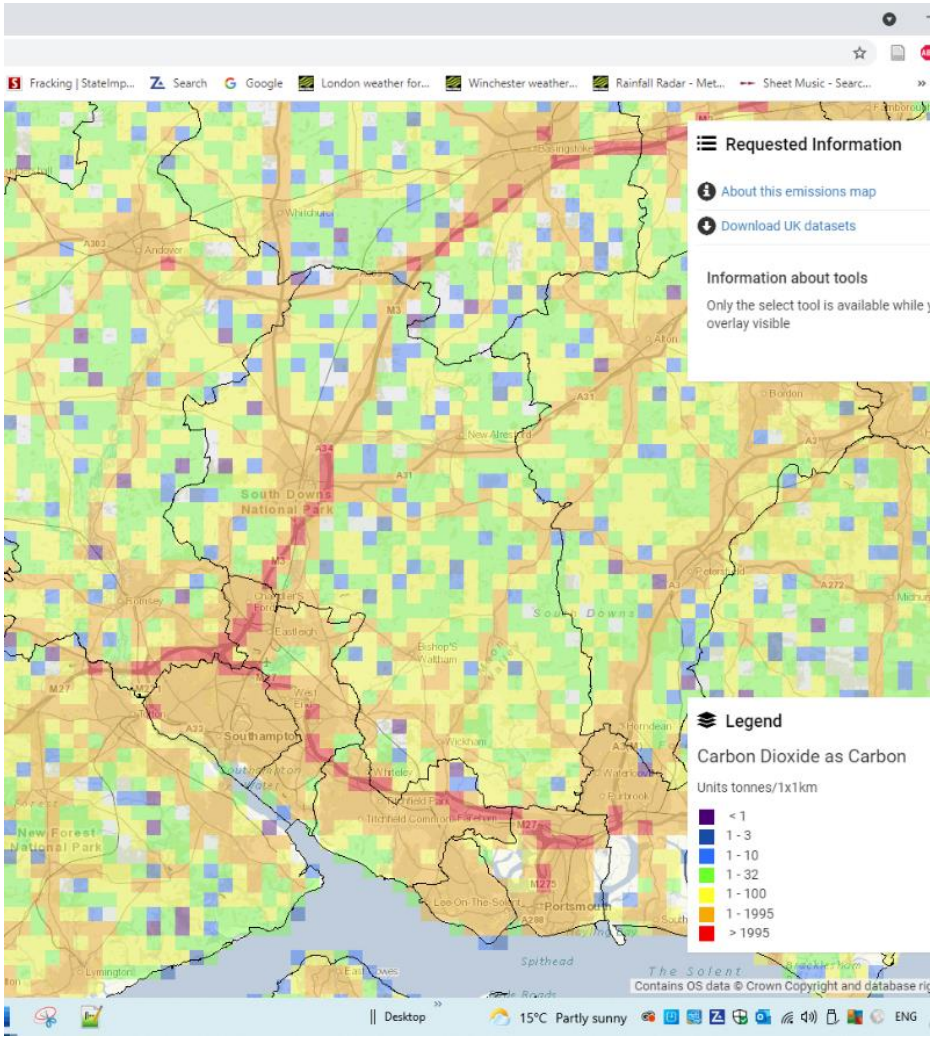


Figure 32. Map of estimated carbon dioxide emissions expressed as carbon in Winchester District (outlined by thin black line) on a 1 x 1 km grid. It clearly shows the higher emissions associated with motorways, main roads and urban areas.

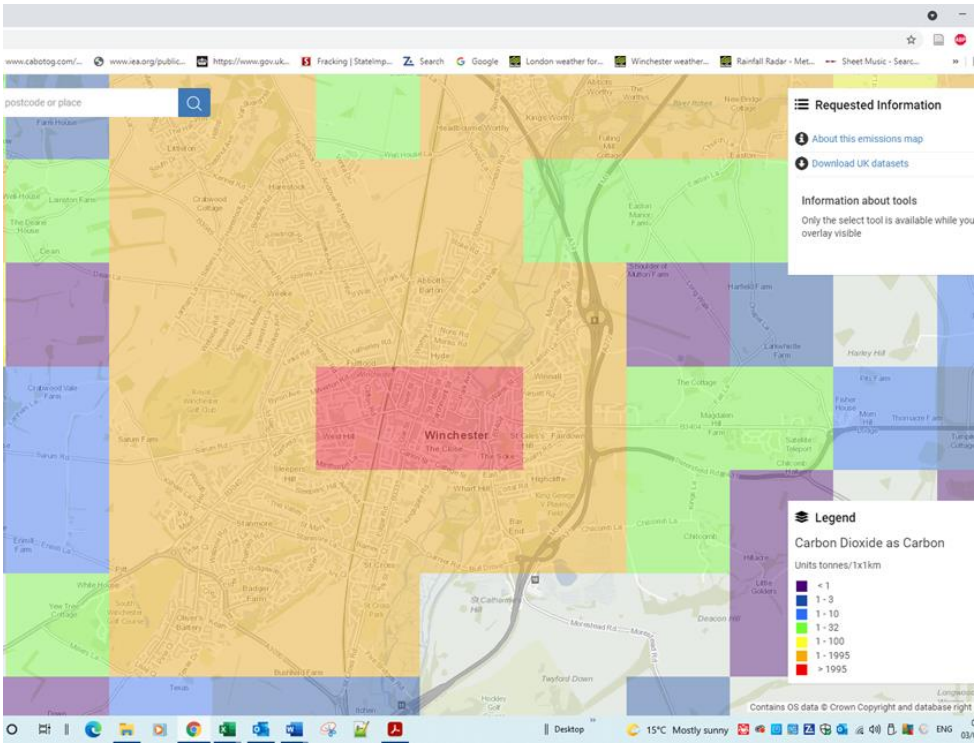


Figure 33. Map of estimated carbon dioxide emissions from 'non-industrial combustion plants' expressed as carbon around Winchester on a 1 x 1 km grid. Note the concentration of emissions from just two grid squares (red) covering central Winchester amounting to at least 4 kt C (14.7 ktCO_2). Grey grid squares have insufficient data.

Discussion

One way to put any discussion of the emissions from Winchester District into a wider context is to consider the global Drawdown Plan in a book edited by Paul Hawken.[58] Their Plausible Scenario with a 'conservative bias' considered 80 solutions to maximise reductions in carbon dioxide emissions by 2050. In six major sectors, which approximately correspond to the sectors discussed above, they found that the top two solutions in each sector were, with their ranking out of the total of 80 (where the top rank is 1):

- Buildings and cities – district heating (27), insulation (31)
- Energy – onshore wind turbines (2), solar farms (8)
- Food – reduced food waste (3), plant-rich diet (4)
- Land use – temperate forests (12), afforestation (15)
- Materials – refrigeration (1), alternative cement (36)
- Transport – electric vehicles (26), mass transit (public transport) (37)

Refrigeration tops the global ranking because of the refrigerants used in refrigerators, air conditioners and heat pumps (often called F-gases). When these gases leak from badly maintained or discarded appliances their warming potential is 'one to nine thousand times greater than that of carbon dioxide'. Globally the next three ranked solutions are onshore wind turbines, reduced food waste and a plant-rich diet all of which could apply to Winchester District.

Much more information on a global scale will become available when the IPCC Working Group III report 'Mitigation of Climate Change' is published in March 2022.

The Committee on Climate Change regularly reports to Parliament on the UK's progress in addressing climate change and reducing emissions.[59] In its latest report it stressed that some behavioural changes resulting from the pandemic could last and would have a significant impact on decarbonisation – particularly home-working and travel choices, including flying. It warned that government will need to work together effectively at all levels to deliver the pathway to Net Zero.

Lastly, the City Council members and officers will be aware that Hampshire County Council has also produced an Action Plan for Carbon Mitigation up to 2025.[60]

Many of the actions suggested in this report require money to implement. This can be used as an argument to do nothing (or much less than what is needed). Doing nothing now to mitigate climate change will cost a lot more for future generations. Ask 'Have you considered the cost of doing nothing? How much will that be?' As former World Bank chief economist Lord Stern estimates, inaction could cost a third of the world's wealth. Once the terrible cost of doing nothing now is understood, climate action today is a bargain.[61]

Another false argument is that the UK accounts for only around 1% of global emissions and reducing our emissions will have little effect. This neglects the emissions created overseas on our behalf. For example, consider the emissions from the ubiquitous items we use in everyday life which were manufactured for us in China and then exported to the UK and other developed countries.

Summary and conclusions

Ignoring the steady decrease in the carbon intensity of electricity, which is driven by the closure of coal-burning power stations across UK, emissions from all sectors in Winchester District have stalled in recent years (Figure 19, Figure 20). Only road vehicle fuel consumption has taken a small downward turn since 2017 but this may be a temporary change.

By far, the largest source of emissions from the district is road vehicles (451 $ktCO_2$), even when motorway traffic is excluded (272 $ktCO_2$), followed by the domestic use of gas (mainly for central heating boilers and hot water; 109 $ktCO_2$). Land use changes (LULUCF) continue to act as an important sink (-49 $ktCO_2$) but they are completely offset by the industrial use of residual fuels.

Looking ahead to 2030 we have tried to estimate how much emissions from some sources could be reduced in the previous nine years and have shown, using various assumptions in a number of scenarios, that savings of 191 $ktCO_2$ are possible, equivalent, when motorway emissions are excluded, to a reduction in emissions of 40%.

Not surprisingly we estimate the biggest savings could be made from road transport (83 $ktCO_2$) and specifically from the reduction in commuting from more people working from home. Other significant contributions could come from a growth in EVs replacing petrol/diesel cars and delivery vans, a reduction in motorway speed limits (70 to 60 mph), and a reduction in the annual mileage of cars. These savings would be enhanced by an immediate ban on the sale of SUVs.

Public buildings are a special case for which Display Energy Certificates are available online and indicate that, at least in some state schools and colleges, there may be room for significant reductions in emissions, mainly from heating fuels, by improved insulation.

But there are other actions we can take, even if we do not have enough data to estimate the size of their impact. So we also listed such areas where potentially savings can be made (Table 16). They include the industrial and commercial use of gas and residual fuels, particularly petroleum products, and agriculture. Commercial confidentiality may be used as an excuse for preventing disclosure of energy consumption figures. Yet CSE's Impact tool shows that two 'business parks' in the parishes of Durley and Curdridge appear to be responsible for emitting 34 $ktCO_2$ which is almost 6% of the district's total emissions (excluding motorways) and around a quarter of all the district's industrial and commercial emissions!

We also list hard-to-quantify actions where a lack of data prevented us from estimating savings up to 2030 (Table 19). Some of these actions, for example in the road transport sector, might be quantified if the City Council used its own data.

Finally, we have noted a number of significant potential changes to national legislation and regulations that could have significant impact before 2030 on emissions related to the environment, new and retrofitted buildings and road and rail transport in particular (Table 20). Such changes are urgently required but appear to be delayed within government.

Suggestions of ways to reduce carbon emissions from Winchester District

We have reviewed the district's emissions so we can suggest how Winchester City Council might reduce carbon emissions from the district in support of its target of net zero by 2030.

As WinACC's reports from previous years show, direct emissions ("territorial," as opposed to consumption, emissions) account for around only 50% of all the district's emissions.

Emissions are not evenly spread throughout the district. Data from the Centre for Sustainable Energy (CSE), Bristol, which provides information at parish and ward level, shows that 71% of household emissions are sourced outside Winchester city.

Main roads, including motorways, and towns with their higher density of housing, contribute more than rural areas. Maps of the National Atmospheric Emissions Inventory show that emissions appear to be concentrated around main roads and populated areas reflecting the burning of fossil fuels by road vehicles and home central heating systems (mains gas, oil and LPG).

Two business parks in rural villages contribute to almost a quarter of all industry and commercial emissions identified by BEIS.

Suggestions for future actions are hampered by a lack of detailed information from BEIS on energy consumption and emissions from the industry (principally manufacturing), commercial and public sectors which are responsible for 21.2% of emissions.

Our quantitative estimates of where future emissions could be cut are necessarily constrained by a lack of data in some areas. For this reason we also suggest a list of other actions, crudely prioritised.

A list of some actions in **Table 21** merges our quantitative and qualitative approaches, with some indication of their likely impact on cutting emissions by 2030. Where the City Council has no direct control but has powers of influence, the proposed actions rely on campaigns and/or consulting with the general public, especially homeowners, and industry and business.

The actions listed in the table do not form a definitive list. Some suggestions are omitted because the City Council has very little power to influence: for example, where progress depends on action by the UK government.

Action to reduce emissions is limited only by imagination.

***Table 21. Suggested* actions for the City Council which contribute to a reduction in emissions from Winchester District by 2030.** *The impact of the actions, if successful, is estimated using a system of stars; * = least impact; *** = most impact. Actions in grey are where the City Council has no direct powers but has influence.*

Action	***Why?***	***How?***	***Impact to 2030***
Finance & Assets			
1. Always apply for national funding for work on climate mitigation.	Increase funding for emissions reduction actions in the district.	Apply, where appropriate with County Council or neighbouring authorities.	***
2. Use WCC investments to help achieve carbon neutrality.	Can provide worthwhile financial returns.	Invest in large-scale renewables or carbon reduction projects. Take advantage of offers from Energy4All and others.	***
3. Decarbonise Hampshire Pension Fund investments.	Investments in fossil fuels industries cause emissions to increase.	Press Hampshire Pension Fund to divest	**
4. Set up Green Fund or Green Bonds.	Assist projects to reduce carbon emissions from the district.	To be explored	*
Road transport			
5. Encourage home working.	Reduce car commuting, reduce demand for office space.	Set an example by allowing Council staff to work at home.	***
6. Make changes within the City Council's powers to deter/disincentivise use of private cars.	Hampshire car numbers have increased by 17% and vans numbers by 61% since 2005. Car mileage increased by 10% and van mileage by 35% since 2009.	Measures include: • Workplace parking levy. • Create low traffic neighbourhoods, traffic-free streets outside schools, encourage play streets, etc. • Congestion charging. • Revise car parking standards for new dwellings, and at change of occupancy. • Embed 15-minute communities in Local Plan.	***
7. Press the County Council to cut emissions from road transport.	Largest source of emissions in Winchester District. Reductions have co-benefits of better air quality and health.	Measures include: • a movement strategy for every town in the district. • integrate transport carbon reduction measures into the Local Plan. • transfer funds from road	***

		schemes to schemes for pedestrians, cycling, or public transport including rail • make good appropriate use of UK government funding e.g. Active Travel • close all roads in Winchester town centre to private vehicles • maximise carbon reduction benefits of County Council's Local Transport Plan 4.	
8. Improve public transport, walking and cycling.	To enable and encourage people to leave car at home.	Press Hampshire County Council to develop an ambitious Bus Service Improvement Plan. Install bus gates. Reallocation of road space to cycling, walking and buses. Improve signage.	**
9. Reduce parking spaces in towns.	To encourage people to leave car at home.	Revise the Parking and Access Strategy to put emissions reduction at its heart. Close all public car parks in towns (except for disabled drivers). Increase all parking charges in towns.	**
10. Discourage SUVs	SUVs have ½ to ¾ of mpg (emissions) of medium-sized cars. Also disproportionately damage road surfaces and verges, and are too wide for many parking spaces.	Campaign Reduce parking spaces for SUVs	**
11. Facilitate the electrification of transport, prioritising public transport (bus, trains), e-deliveries, and essentials such as medical transport and tradespeople.	Essential transport must have priority for the limited renewable electricity that will be available for transport once energy is decarbonised.	Charging points. Financial incentives e.g. parking charges for electric vehicles.	**
Cut emissions from homes			
12. Whole home retrofit of existing homes including replacing fossil fuels (oil/gas) with systems fuelled by low carbon energy e.g. heat pumps.	Reduce emissions, with co-benefits of more comfort, better health.	*Council stock:* make maximum use of government funding schemes e.g. LAD *Private:* Campaign, make maximum use of government grants, RHI or similar, fully insulate homes	***
13. Replace domestic heating using fossil fuels (oil/gas) with systems fuelled by low carbon energy e.g. heat pumps.	Reduce emissions, with co-benefits of more comfort, better health.	*Council stock:* make maximum use of government funding schemes e.g. LAD *Private:* influence, work with communities to support homeowners with grants etc	***

14. Reduce emissions from gas central heating boilers.	Domestic gas emissions are 18% of district's total.	*Council stock:* Ensure all condensing boilers are correctly set up to condense efficiently *Private:* campaign to ensure all condensing boilers are correctly set up to condense efficiently; work with communities and installers	*
15. Improve energy standards of new housing.	Gas boilers likely not permitted after 2025; heat pump alternatives are available now. Reduce emissions, with co-benefits of more comfort, better health.	Apply changes expected in New Homes Standard, Building Regs.; build to Passivhaus/NEF SuperHomes standards. Do not approve new homes with mains gas or oil/LPG heating	**
16. Encourage behaviour changes e.g. optimise all central heating settings, lower room thermostat settings	Reduce emissions.	*Council stock*: Campaign. *Private:* Campaign	*
Cut emissions from non-domestic buildings			
17. Reduce electricity and gas consumption.	Electricity and gas consumption from non-domestic sector is 12.5% and 6.3% of district's total emissions respectively.	Campaign, inform building managers. Action is required in addition to the nationally driven reduction in carbon intensity of electricity up to 2024. Revisit options for local heat networks driven by heat pumps.	**
18. Retrofit of existing buildings, including replacing gas boilers with heat pump or heat network; fully insulating.	Reduce emissions, with co-benefits of more comfort, better health.	Act on Council buildings Lobby other bodies	**
19. Improve standards of new buildings.	Reduce emissions, with co-benefits of more comfort, better health.	Planning: apply changes expected in Building Regs.; aim for Passivhaus/ NEF SuperHomes standard	**
Improve energy performance of public buildings			
20. Check public building DECs are up to date.	A legal requirement. Drawing attention to the facts may prompt action.	Consult MHCLG database; apply regulations	**
21. Encourage public buildings to reduce energy consumption per square metre of floor space.	Some public buildings, including schools and colleges, have energy/m2 well in excess of the Passivhaus standard.	Campaign, present options to building managers include aiming for higher standards (Passivhaus, NEF SuperHomes)	**
Campaign for plant-based diets			
22. In public sector canteens and schools.	Reduce carbon footprint of food.	Regulations, Campaign	**
23. In restaurants and pubs.	Reduce carbon footprint of food.	Campaign restaurants and pubs	*

Land use and agriculture			
24. Planners to always prefer brownfield sites over greenfield sites.	This will protect forests and grasslands, which are both significant carbon sinks, from development and other changes in use.	Planning, Regulation	**
25. Discover why agriculture emissions are increasing.	14.2% increase in emissions since 2013 and now back to 2006 levels. No publicly available data on energy use by farms.	Work with South Downs National Park Authority to build on / replicate their work with farmers. Disseminate good practice on land use and regenerative agriculture. Encourage all landowners to measure their carbon footprint using one of the three UK market leading apps.	*
26. Provide land for allotments.	Home grown food cuts emissions; co-benefits of health and exercise.	Allocate land in the district – including in the Local Plan.	*
Emissions from business and industry			
27. Discover why 'business parks' in Curdridge & Durley have high energy consumption and take appropriate action.	They contribute almost 25% of the district's industry and commercial emissions.	Consult businesses.	***
28. Find ways to extract energy consumption and residual fuel data relating to businesses and industry	Around 30 businesses employ over 250 people and are likely to be the biggest business emitters in the district.	Consult with larger businesses; ask businesses to approach BEIS to remove current restrictions on publicising their metered energy consumption.	*
29. Support the revival of the Hampshire Bank.	Will fund green businesses.		*
30. Make a "circular economy" the aim of the Green Economic Plan.	A circular economy reduces the use of new materials in manufacturing.	Add to the Green Economy 10 year strategy.	**
31. Encourage low-carbon economy businesses.	Low carbon businesses reduce emissions.	Provide premises for low-carbon start-ups.	*
Renewable energy generation			
32. Encourage developers to submit proposals for large-scale renewable energy generation.	Renewable energy generation contributes to meeting UK emissions target	Promote renewable energy production in new developments. Identify sites for wind and solar power in Local Plan. Facilitate commercial development in suitable locations.	***
33. Support communities to create their own renewable energy schemes.	Both a contribution to low carbon energy and to strengthening community determination to act on the climate crisis.	Support messaging via parish councils and WeCAN. Offer planning advice.	*

Part 4. Resources

This lists other sources of information which may be useful in selecting priorities for action in Winchester District, with brief explanations or summaries where needed (in green if quoted from the source). These sources are likely to change from year to year.

Tools and calculators of emissions data at county / district / parish / Super Output Area level

1. **CSE Impact tool** main webpage https://impact-tool.org.uk/.

   For a video overview: https://youtu.be/HrakotnIaFo

   For a more detailed explanation of the tool: **Impact Carbon Footprint User Guide video CASE Feb 2021** https://www.youtube.com/watch?v=Q8aM9_9CdPw

   "This 10 minute video helps users understand how to use the Impact carbon footprinting tool, and the difference between the territorial and consumption-based footprinting approaches used within it."

2. **CSE Impact tool reports for each parish in Winchester District** - *CSE 2021* https://www.winacc.org.uk/wecan/

3. **WinACC analysis of consumption emissions broken down by parish, City Council ward and County Council division** using data from CSE Impact tool. https://www.winacc.org.uk/wp-content/uploads/2021/10/20211021-winchester-consumption-emissions-v4.pdf

4. **Place-based carbon calculator** *July 2021* https://www.carbon.place/ "PBCC is a free tool which estimates the per-person carbon footprint for every Lower Super Output Area (LSOA) in England. LSOAs are small statistical areas with a population of about 1,500 - 3,000. It draws on a wide range of data and research to give a representative view of how carbon footprints vary across the country. PBCC is intended to help communities and policy makers understand where their carbon footprints come from and what we need to do to reduce them. It is based on a consumption based approach to carbon footprints, drawing on the best available data and research for each part of our carbon footprint.

   The main part of the tool is an interactive map of England. Clicking on any of the LSOAs shown on the map will bring up a local report card. The report card contains more information on how the carbon footprints were calculated, as well as comparisons with other areas.

   The PBCC is an open source project and you can use the code and data subject to their respective licences.

5. **MacKay Carbon Calculator** UK emissions and primary energy consumption) *Department for Business, Energy and Industrial Strategy (beis.gov.uk) Dec 2020*. This provides a model of the UK energy system that allows you to explore pathways to decarbonisation, including net zero by 2050, at national level. The Gov.uk webpage (https://www.gov.uk/guidance/carbon-calculator) introduces it thus:

   There are 2 online versions of the calculator, a universal version called My2050 and an open the detailed version of the calculator

Both versions contain levers of decarbonisation, 15 in My2050 and 45 in the detailed version. You select your level of ambition of decarbonisation effort using the levers, ranging from Level 1 - minimal effort, to Level 4 - maximum effort. Popup descriptions explain what the levels represent in terms of behavioural change or infrastructure investment.

This link is set to "Business as Usual" (for UK).
https://mackaycarboncalculator.beis.gov.uk/overview/emissions-and-primary-energy-consumption/?levers=1111111111111111111111111111111111111111111111aaabaaabaaabaaaaaaaaaaaabbabbbcbbaabcaabbaaaagggggggggggggeggggggggggiggiiiqgdgggggggkgg.

Here is the tool with net zero set at 2035:
https://mackaycarboncalculator.beis.gov.uk/overview/emissions-and-primary-energy-consumption/?levers=4441114214444424344444414B1v41A34444244444444aaabaaabaaabaaaaaaaaaaaabbabbbcbbaabcaabbaaaagggggggggggggeggggggggggiggiiiqgdgggggggkgg

This link goes to 'ESC illustrative net zero' setting
https://mackaycarboncalculator.beis.gov.uk/overview/emissions-and-primary-energy-consumption/?levers=3BB1113311v33222321233123B1w21B3v22132123BBA2aaabaaabaaabaaaaaaaaaaaabbabbbcbbaabcaabbaaaagggggggggggggeggggggggggiggiiiqgdgggggggggkgg These settings produce a result compatible with the latest government target of 78% reduction on 1990 emissions by 2035.

A complete Excel spreadsheet is downloadable from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/940672/Excel_MacKay_Carbon_Calculator_v198.xlsm. The spreadsheet contains all the calculations behind the tools.

A variety of associated tools can be accessed by clicking on the "i" tool next to the words "MACKAY CARBON CALCULATOR" in the top left including the learning material and simpler tool "My 2050" .

6. **My2050** (https://my2050.beis.gov.uk/?levers=111111111111111) is the simplified calculator tool. A picture of a German town changes depending on how you set the levers (e.g. traffic jams disappear, a wall becomes thicker with more insulation etc).

Local public opinion / behaviour change

7. **Climate Change: findings from Hampshire Perspectives**, Hampshire County Council's online residents' forum *HCC May 2021*
https://documents.hants.gov.uk/aboutthecouncil/ProjectSeven-ClimateChange.pdf

8. **Climate Change Behavioural Insights Final Report** *HCC May 2020* – 170 page presentation
https://democracy.hants.gov.uk/documents/s53572/Climate%20Change%20Strategy%20-%20Appendix%203-2020-07-14-Cabinet.pdf

The County Council's "Insight and Engagement Unit was tasked with delivering initial research to inform the approach to behaviour change. The research was designed to support local authorities to work with their partners to reduce carbon consumption through changed behaviours by addressing two key questions: The research identified

the key opportunities for, and barriers to, achieving desired behaviour changes among citizens by exploring people's capacity, opportunity and motivation to change behaviour - and by assessing how much change might be possible, where, with whom (including demographic and Mosaic profiles) and when. An assessment of the carbon impact of desired behaviour changes, together with potential health benefits, was also undertaken. The research assessed the evidence of the most effective ways of communicating and ultimately achieving behaviour change."

Local authorities and climate change

9. **Local authorities and the 6th carbon budget** *Committee on Climate Change, Dec 2020* https://www.theccc.org.uk/wp-content/uploads/2020/12/Local-Authorities-and-the-Sixth-Carbon-Budget.pdf

   This is largely focused on policy change, much at national level. They list these over-arching priorities for local authorities:

   • Develop Net Zero or Climate Action Plans with delivery projects ….

   • Monitor and report on progress … share standardised data, benchmark and provide clear evidence to inform policy.

   • Conduct policy and service reviews to align policy, spending and functions with Net Zero. Identify contradictions, then put in place mitigation plans to align them at a future date and reduce emissions in the meantime. Develop project and financial appraisal systems that include emissions and climate impacts.

   • Implement training and capacity building … within the local authority and with key suppliers and contractors. Climate, energy, sustainability and carbon understanding needs to be embedded in the whole authority, across staff and systems. …

   • Develop capacity to innovate and scale up. Climate change action plans help identify future delivery projects for when funding becomes available. Local authorities should prioritise applying for funding and managing funds if successful. …

   • Collaborate with neighbouring and cross-tier local authorities and other key delivery bodies … energy, transport, housing, infrastructure and skills.

   • Develop Green Finance know-how. Private sector investment and Green Finance will be required … Local authority legal and finance teams, and project delivery teams will need to develop their knowledge of the finance industry.

   • Communicate and engage with local communities, businesses and partners on Net Zero so that a mandate for action is maintained. Support community action …

   • Local authority pension funds should disclose their approach to assessing and managing climate risks and should consider investing in Net Zero aligned schemes within their legal duties.

10. **What are other councils doing?** 'Step Change: Report back on 2021 Networking Event | South East Climate Alliance (seclimatealliance.uk)

11. **Tools for local authorities,** *Ashden* https://ashden.org/tools-for-councils/ *2020:*

    - **Climate Action Co-benefits Toolkit** https://ashden.org/wp-content/uploads/2020/09/CAC-Chapters-all_new-brand.pdf "helps local authorities

build the business case for climate action. It lays out how lowering emissions also creates improved health, social equality, thriving economies and community resilience. These wider benefits engage citizens in climate action – boosting public support for further change. The toolkit features case studies, region-specific data, and links to a wide range of resources, including reports and **videos**.

- **31 Climate Actions for Councils** A spreadsheet listing 31 actions: what needs to be done by whom, the cost and the carbon saving: https://ashden.org/wp-content/uploads/2020/09/31-actions-for-councils-v4-June2020.xlsx, and a report https://ashden.org/wp-content/uploads/2020/08/31-Climate-Actions-for-Councils.pdf **"** both aiming to "help councils choose the right interventions for their communities. They also point to examples of best practice around the UK."

Hampshire County Council

12. **Current and Planned HCC Activity Carbon Mitigation** - *Hampshire County Council Climate Change Action Plan 2020*https://documents.hants.gov.uk/climate-change/Climate-Change-Action-Plan-2020-2025.pdf

Winchester District

13. **Winchester District Carbon Neutrality Action Plan** *Winchester City Council July 2021* *https://www.winchester.gov.uk/assets/attach/20541/Carbon-Neutrality-Action-Plan.pdf*
14. **Winchester District Green Economy Strategy** *Winchester City Council 20 October 2021* (*https://democracy.winchester.gov.uk/ieListDocuments.aspx?CId=136&MId=2703&Ver=4*
15. **Priorities for reaching Carbon Neutrality by 2030** *WinACC Feb 2021* https://www.winacc.org.uk/wp-content/uploads/2021/02/winchester-climate-emergency-priorities-2021_02_03.pdf -
16. **Winchester City Council Carbon Neutrality Action Plan 2020 – 2030** *WinACC 2021.* Comments on Winchester City Council carbon neutrality declaration and first action plan
17. **Greenhouse gas emissions in Winchester District: Part X Estimates and trends (2005-2018)** Bob Whitmarsh. *WinACC 2020***.** https://www.winacc.org.uk/wp-content/uploads/2020/09/greenhouse-gas-emissions-in-winchester-district-2020-final-v2-1.pdf **.** An annual report pulling together data and saying what it means

Parishes and small community groups

18. **Conference report**, *WinACC February 2021*. https://www.winacc.org.uk/wp-content/uploads/2021/04/2021_02_23-communities-on-climate-change-report-no-contact-info.pdf At a virtual meeting for anyone who was active on the climate, or who wanted to be active in their community across Winchester District, almost 60 people shared their activities and plans, setting out the support they needed from the network, WinACC or the City Council.
19. **Surveys of parish/community activity on the climate,** *WinACC May 2021* Findings https://www.winacc.org.uk/wp-content/uploads/2021/06/wecan-summary-report-of-parish-council-surveys-may-2021.pdf

Surveys were sent to parish councils and community climate groups to find out where climate emergency activity is already happening (and where it isn't), and the support that communities need to respond to the climate emergency.

20. Parish and Town Councils: acting on climate change *WinACC 2020* - simple ideas from workshops in the Winchester district. https://www.winacc.org.uk/wp-content/uploads/2020/11/parishtown_council_climate_change_ideas-2020_11_28.pdf

21. **Four projects working with communities on climate change** *Hampshire County Council 2020* https://www.hants.gov.uk/landplanningandenvironment/environment/climatechange/whatarewedoing/projects

The national context

22. **UK's carbon footprint.** *UK Government, Department for Environment, Food & Rural Affairs, 2020* https://www.gov.uk/government/statistics/uks-carbon-footprint

23. **Atmospheric emissions: greenhouse gases by industry and gas.** Office for National Statistics, 2019 https://www.ons.gov.uk/economy/environmentalaccounts/datasets/ukenvironmentalaccountsatmosphericemissionsgreenhousegasemissionsbyeconomicsectorandgasunitedkingdom

24. **Regional and local authority electricity consumption statistics.** UK Government, Department for Business, Energy & Industrial Strategy, 2019 https://www.gov.uk/government/statistical-data-sets/regional-and-local-authority-electricity-consumption-statistics

25. **Lower and Middle Super Output Areas gas consumption.** UK Government, Department for Business, Energy & Industrial Strategy, 2019 https://www.gov.uk/government/statistics/lower-and-middle-super-output-areas-gas-consumption

26. **Domestic Energy Performance Certificates (September 2020)**, Energy Performance of Buildings Data England and Wales, Ministry of Housing, Communities & Local Government https://epc.opendatacommunities.org/docs/copyright

27. **Sub-national electricity consumption data; Postcode level electricity statistics** UK Government, Department for Business, Energy & Industrial Strategy, 2019 https://www.gov.uk/government/statistics/postcode-level-electricity-statistics-2019-experimental

28. **Sub-national gas consumption data; Postcode level gas statistics.** UK Government, Department for Business, Energy & Industrial Strategy, 2019 https://www.gov.uk/government/statistics/postcode-level-gas-statistics-2019-experimental

29. **National Atmospheric Emissions Inventory.** National Atmospheric Emissions Inventory, 2019 https://naei.beis.gov.uk/data/mapping

30. **Road transport energy consumption at regional and local authority level.** 2019, UK Government, Department for Business, Energy & Industrial Strategy.

https://www.gov.uk/government/statistical-data-sets/road-transport-energy-consumption-at-regional-and-local-authority-level

31. **All vehicles (VEH01)** *UK Government, Department for Transport, 2020* https://www.gov.uk/government/statistical-data-sets/all-vehicles-veh01

The global context

32. **Climate Change 2021: the physical science basis** *IPCC August 2021*- links to summary and full report and more at https://www.ipcc.ch/report/sixth-assessment-report-working-group-i/

33. **IPCC Report: Global Emissions Must Peak by 2025 to Keep Warming at 1.5°C – We Need Deeds Not Words** *Keith Baker. The Conversation (blog), August 9, 2021* https://theconversation.com/ipcc-report-global-emissions-must-peak-by-2025-to-keep-warming-at-1-5-c-we-need-deeds-not-words-165598

"The report's conclusion that staying below 2°C this century will only happen if emissions reach net zero by 2050 is well publicised. But there is one, rather more urgent addendum to that: global emissions must peak some time in the middle of this decade. In other words, within the next few years."

34. ***Main sources of carbon dioxide emissions,*** *CO2 Human Emissions (che-project.eu) Dec 2017* https://www.che-project.eu/news/main-sources-carbon-dioxide-emissions

Appendix – Technical Background

Statistics for annual energy consumption and carbon dioxide (CO_2) emissions in the Winchester District (and other localities) are collected and published by BEIS.

Information about the statistics and how they are compiled are given in a methodology and guidance booklet[62] for energy consumption data, and in a summary[63] and a technical report[64] for carbon dioxide emissions. Much of the work is done in collaboration with Ricardo Energy & Environment[65].

Consumption and emissions are reported on a 'territorial' basis whereby they are generally assigned to the location where the consumption or emission occurs.[l] Emissions associated with electricity-generation are a significant exception, being assigned to the location where the electricity is consumed.

Energy consumption statistics

Energy consumption data at the local authority level is generally reported as either gigawatt hours (GWh[m]) for oil, electricity and gas or kilotonnes[n] of oil equivalent (ktoe[o]) for transport fuels or residual fuels, where 1 ktoe = 11.63 GWh.

Energy consumption is divided into for major categories: electricity, gas, road transport fuels, and residual fuels[66]. Two major areas of energy consumption – aviation and shipping – are excluded.

Electricity. Electricity consumption statistics, published in December 2020, are aggregated (added together) from individual meter readings for the period 31st January 2019 to 30th January 2020 (domestic meters) and from January 1st to December 31st 2019 for non-domestic half-hourly meters. The figures have not been weather-corrected[67].

The figures are divided between 'domestic' and 'commercial'. Consumers using less than 50,000 kWh in the year are automatically classified as domestic, those using 100,000 kWh or more as commercial, and the rest are classified based on evidence such as the address.

Gas. Gas consumption statistics, published in December 2020, were aggregated from individual meter readings for the period mid-May 2019 to mid-May 2020 and have been weather corrected. Consumers using less than 73,000 kWh are classified as 'domestic' even though some of these may be small businesses. The rest are classified as 'commercial'.

Road transport fuels. These statistics, covering the calendar year 2019 and published in June 2021, include petrol and diesel which account for most road transport fuels, but exclude LPG, biofuels and electricity. The figures are modelled estimates of where the fuels are consumed, in contrast to sub-national statistics

[l] See, for example the discussion by the Centre for Sustainable Energy on different ways of assigning carbon footprints: https://impact-tool.org.uk/static/doc/Impact-methodology-paper-v1.6.pdf.
[m] 1 GWh = 1 million kWh
[n] 1 tonne = 1000 kg. 1 kilotonne = 1000 tonnes.
[o] 1 ktoe is a fixed amount of energy meant to represent the energy in 1 kilotonne of oil.

reported in the Digest of United Kingdom Energy Statistics (DUKES) which are based directly on fuel sales. Consumption is divided into six vehicle types – buses, motorcycles, petrol cars, diesel cars, light goods vehicles (LGV) and heavy goods vehicles (HGV) – and three road types – minor roads, A-roads and motorways.

Residual fuels. The statistics, published in September 2020, for the consumption of residual fuels, that is all non-gas, non-electricity and non-road transport fuels, are modelled estimates for calendar year 2018. They include consumption of petroleum products, coal, manufactured solid fuels and "renewables and wastes". Fuel consumed by aviation, national shipping, power stations and heat sold are excluded.

CO_2 emissions

CO_2 emissions are reported as kilotonnes of CO_2 ($ktCO_2$). CO_2 emissions can be estimated directly from energy consumption data by using appropriate conversion/emission factors[68]. Nevertheless, we follow the convention of using national territorial emissions data for different sectors, provided by BEIS in June each year, which they have disaggregated (separated out) using modelling on an end user basis down to local authority level by Ricardo Energy on behalf of BEIS.[69] These results now also include modelled emissions data for land use, land use changes and forestry (LULUCF) for six major categories involved (both sources and sinks) which were previously reported annually by the Centre for Ecology & Hydrology.

Indirect and consumption emissions

As noted above, the CO_2 emissions described here only relate to emissions that occur directly from measured or modelled energy use or land use activity in the Winchester District. While accounting for emissions this way (territorially) will ultimately account for all measurable emissions globally, it means that for a low-industrial area (or even a country) such as Winchester District or the UK, many emissions are assigned to another location (often overseas).

Last year's report by WinACC contains a detailed discussion of these issues[70], concluding that the direct CO_2 emissions based on BEIS figures constitute less than 50% of the emissions 'caused' by Winchester District through its domestic and commercial activities.

The Centre for Sustainable Energy (CSE), working with Exeter University, have modelled consumption (as well as territorial) emissions for regions down to the parish level using numerous data sources[71].

Statistics for previous years

A complete set of statistics is compiled each year by BEIS along with accompanying documents and includes (sometimes revised) previous years' statistics back to 2005. The 2021 publication covers the years 2005-2019. BEIS considers comparisons using these figures are only reliable back to 2005.

BEIS also notes, with regards to previous years' publications, that "On occasions, previously published data will need to be revised. These revisions are usually due to forecasted values being replaced with actual data, where actual figures were not available at the time of publication. Annual revisions are made to the road transport and residual fuels data." BEIS

have also made revisions to electricity and gas consumption figures. Consequently, all graphs produced here, and WinACC's conclusions from them, may differ (usually only in minor detail) from those published in previous years.

Other greenhouse gas emissions

As well as omitting indirect emissions, as discussed above, BEIS statistics do not include non-CO_2 greenhouse gas emissions. The most significant of these is methane (CH_4), a potent greenhouse gas with 1 molecule of CH_4 having around 28 times the warming potential of a molecule of CO_2 over a period of 100 years[72]. One estimate is that CH_4 emissions contribute around 28% of global warming [73]. Methane is released by agriculture, landfill sites and from gas leaks associated with natural gas (which is mainly methane) extraction and supply[74]. Nitrous oxide (N_2O) is another potent greenhouse gas which is typically released by de-nitrifying bacteria in the soil and is increased by over-use of nitrogen-based fertilizer[75].

When emissions for all greenhouse gases are reported they are usually quoted as kilotonnes of carbon dioxide equivalent ($ktCO_2e$) based on their predicated global warming potential (GWP) relative to CO_2. Essentially the GWP of a greenhouse gas is the number of molecules of CO_2 that would cause the same global warming as one molecule of the gas. GWPs are complicated by the fact that the amount of time each greenhouse gas stays in the atmosphere lifetime of each gas is different - for example CO_2 remains unchanged for many hundreds of years while CH_4 is mainly converted into CO_2 by photochemical reactions in around 12 years – so the quoted values can vary and the actual warming potential for any specific emission depends on the period of time under consideration – see Table 22.

Table 22. Greenhouse gas global warming potentials and atmospheric lifetimes. Source IPCC[76].

Greenhouse gas	GWP (100 years)	GWP (20 years)	Atmospheric lifetime
CO_2	1	1	100s of years
CH_4	25	72	~12 years
N_2O	310	289	114 years

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[3] Sub-National Consumption Statistics Methodology and guidance booklet https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/946789/sub-national-methodology-and-guidance-booklet-2020.pdf

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