Surrey Climate Commission

SURREY CARBON BASELINE STUDY

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Centre for Environment and Sustainability

UNIVERSITY OF SURREY

Surrey Climate Commission

About the Surrey Climate Commission (SyCCom)

The Surrey Climate Commission (SyCCom) was established voluntarily in early 2019 in order to act as an independent voice, providing advice and leadership on strategies to help achieve the necessary carbon reduction targets in Surrey. It was proposed to help achieve at least zero carbon by 2030, in line with the IPCC Technical Summary on Global Warming of 1.5°C (Allen et al., 2019). This will require local plans and actions, in addition to that already being led at the national level, and should be done in such a way as to help make Surrey a better, healthier, more equal and more climate resilient place to live.

SyCCom has set itself the following underlying objectives:

- To assess where the County of Surrey is currently in relation to hitting its required carbon reduction targets;
- With assistance from other groups, work to develop a Climate Change Action Plan that aims to provide options and proposals on how carbon reduction goals can be achieved;
- To monitor and review progress on this Plan;
- Engage on this Plan with a range of organisations in the county, including from Local Government, public sector organisations (e.g. NHS), NGO's, the Business Community, schools/colleges, local communities and consumer groups;
- To help enable the above organisations to make positive choices with regards to the climate/environmental aspects of their projects and operations. In particular:
    - To signpost the facility of private and public funding towards climate and environmentally friendly projects;
    - To provide or facilitate provision of advice on suitability of projects or assessment of climate related risks;
    - To act as a forum where organisations can share best practice and formulate new ideas on Climate Change reduction;
    - To help inform and influence Climate Change Policy.

FIND OUT MORE

The SyCCom website: https://www.surreyclimate.org.uk/

UK Place-Based Climate Action Network: https://www.pcancities.org.uk/

Surrey County Council on Surrey's climate change strategy: https://www.surreycc.gov.uk/people-and-community/climate-change/what-are-

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1.0 EXECUTIVE SUMMARY

Introduction

The world faces a climate crisis – the damaging impacts of global heating as a result of our burning of fossil fuels and of damaging practices in land use, generating greenhouse gas emissions such as carbon dioxide and methane. The UK is committed to net-zero greenhouse gas emissions in our economy by 2050. Many organisations in Surrey, including the County Council, aim to achieve net-zero from their operations by earlier dates – 2030 for example.

The transition to a net-zero economy and society in Surrey, as in the rest of the UK and the developed world, will require major changes to many aspects of the ways in which we work, travel and consume. Decarbonising the economy is a massive challenge but also opens up opportunities on a major scale to improve wellbeing, enhance nature, generate new jobs and skills, and help enterprises thrive. To help understand the actions we need to take, and how effective they are, it is important that we have a baseline understanding of Surrey's carbon emissions at present.

This report for the Surrey Climate Commission (SyCCom), produced by a team at the University of Surrey, offers an initial carbon footprint analysis. It is intended to contribute to the essential baseline of knowledge and evidence required to enable the Commission and its members and partners to:

- identify a total carbon footprint for the county and see how it changes over time - and how far we are making progress towards net zero greenhouse gas emissions in the county overall, and in specific sectors and areas, over the next few decades;
- monitor actions and the impacts of changes in the economy and environments of Surrey ;
- demonstrate the impacts and success of policy interventions ;
- identify hotspots: areas to focus policy development and implementation, and where 'rapid wins' might be possible ;
- identify key pathways and projects for rapid decarbonisation;
- identify gaps in data and understanding, and areas where additional evidence will offer opportunities to improve the baseline.

Headline findings

Travel and transport are responsible for 50% of Surrey's carbon emissions, with around 66% due to car usage.

The homes within the county create 32% of emissions with a declining proportion being generated from electricity used, as the county benefits primarily from the greening of the national electricity grid. Today 70% of the carbon emissions from Surrey homes are created by gas central heating systems.

In Surrey 21% of emissions are generated by commercial and industrial activity. This includes emissions from public sector buildings and other activities. Datasets for the public sector remain incomplete.

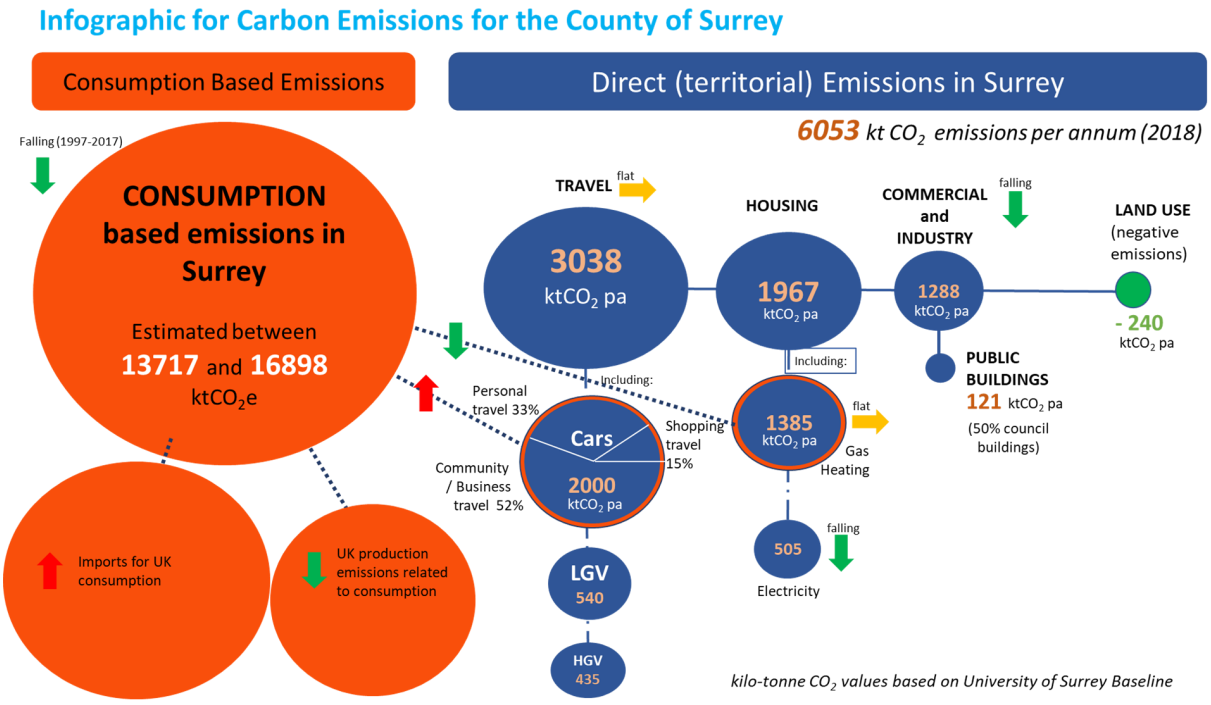
As a largely rural county Surrey provides

opportunities for capture of carbon, through forested areas and grasslands. In 2018 it is estimated that around 240ktCO_2 were sequestered.

It is important to try to account not only for the emissions from carbon-generating production and other activities in Surrey (production-based or territorial emissions) but also for those associated with consumption (for example, carbon embodied in imported consumer goods). We estimate that carbon emissions arising from consumption by Surrey organisations and residents are broadly double the total of production emissions, ie those generated by organisations and activities within the county.

See the graphic below for a summary of the baseline assessment of carbon emissions for Surrey.

Figure 1: Baseline Assessment of Surrey's Carbon Emissions (2018)



Source: adapted from a visualization of the data provided by Paul Street, 2sustain

2.0 INTRODUCTION TO THE REPORT

The world faces a climate crisis – the damaging impacts of global heating as a result of our burning of fossil fuels and of damaging practices in land use, generating greenhouse gas emissions such as carbon dioxide and methane. The UK is committed to net-zero greenhouse gas emissions in our economy by 2050. Many organisations in Surrey, including the County Council, aim to achieve net-zero from their operations by earlier dates – 2030 for example. (See Appendix 1 for an overview of climate science and UK national policy; and see Appendix 2 for a summary of current commitments by Surrey County Council and other local government bodies in Surrey).

The transition to a net-zero economy and society in Surrey, as in the rest of the UK and the developed world, will require major changes to many aspects of the ways in which we work, travel and consume, and to our use of land. Decarbonising the economy is a massive challenge but also opens up opportunities on a major scale to improve wellbeing, enhance nature, generate new jobs and skills, and help enterprises thrive. To help understand the actions we need to take, and how effective they are, it is important that we have a baseline understanding of Surrey's carbon emissions at present. This can then be used to assess trends and progress in cutting the county's emissions.

This complex work has been started by Surrey County Council, and this report for the Surrey Climate Commission, produced by a team from the University of Surrey, aims to complement and build on the estimates and data already gathered. In further work with partners such as the County Council we will continue to refine the baseline analysis, fill in gaps in data, and enable effective tracking of progress in monitoring and reducing greenhouse gas emissions.

2.1 OBJECTIVES OF THE BASELINE STUDY

The major impacts being identified through climate science create an imperative to reduce carbon emitting activities (see Appendix 1 for an overview of climate science and UK national policy on emissions reduction). This has led to policy demands to achieve net-zero carbon emissions within timescales ranging from approx. 2030 to 2050 (depending upon organization, government etc.). To help understand the actions we need to take and how effective they are it is important that we have a baseline understanding of Surrey's carbon emissions at present.

Here we use the general term 'carbon emissions' to mean the emissions of all recognized greenhouse gases expressed in terms of their Carbon Dioxide (CO_2) equivalents, based on the conversion factors for the global warming effect of the different greenhouse gases over a 100-year timeframe published by the Intergovernmental Panel on Climate Change (IPCC). In developing this baseline we have considered not only the emissions that are directly emitted from homes, businesses, vehicles and land use within Surrey, but also the indirect carbon emissions – those embedded in the products and services we buy.

A baseline carbon footprint allows policy-makers across sectors to:

- identify a total carbon footprint for the county: allows us to monitor actions and change and to demonstrate the success of interventions;
- identify hotspots: areas to focus policy development and implementation, rapid win pathways and projects;
- identify gaps in data, highlighting needs and opportunities to improve the base-line.

2.2 SUMMARY OF METHODOLOGY

This baseline study has utilised data sources to achieve four overarching aims:

- to ensure it has maximum compatibility with national statistics, especially end user territorial based data at a subnational local authority level e.g. BEIS/ONS (NAEI, 2018) and to work with other Climate Commissions (and similar bodies) to develop a standardized approach. This aim is fully in line with the carbon baseline approach adopted by Surrey County Council in their Climate Change Strategy (2019);
- to ensure that it can provide an overview of emissions from both a production and consumption perspective – that is, measuring emissions produced within Surrey from diverse sources, and the emissions produced elsewhere but embodied in goods consumed in the county;
- To present the data based on the distinct communities within Surrey: residents and visitors, businesses, public sector and land use;
- to ensure that we have data broken down to the most detailed levels possible for different sectors and areas in the county.

Below we summarise the data sources and methods used. A detailed account of the methodology used is given in Appendix 3.

Overview of sources for carbon footprint baseline study

We reviewed a wide range of sources of data on carbon measurement at sub-national level. The materials were consolidated into 5 categories:

1. Carbon footprinting methodologies at a sub-national level;
2. National databases offering sub-national information;
3. Surrey-specific emissions data;
4. General information on sub-national emissions;
5. Projections.

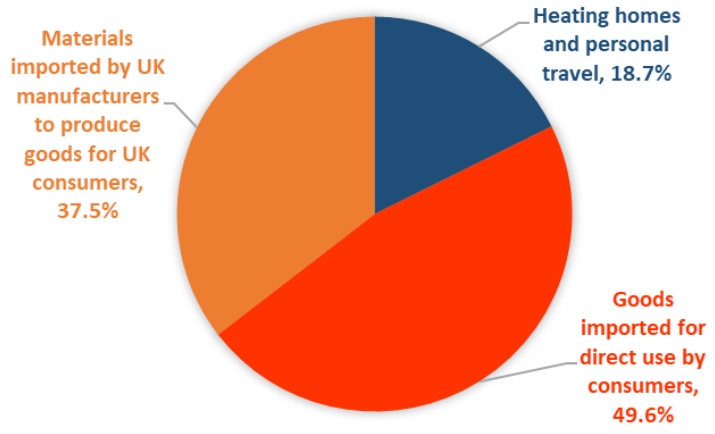
3.0 SURREY CARBON BASELINE

Statement of Scope

Just as organisations may focus on the carbon emitted from their own operations so it is quite feasible to set the boundary for this carbon baseline as the 'territory based' emissions of the County of Surrey.

As the UK has manufactured less and imported more goods and services we have 'offshored' many of our carbon emissions. These are now embedded in the products and services we buy. The total UK carbon footprint in 2017 was 772 million tonnes CO_2 equivalent ($MTCO_2e$) (DEFRA, 2018).

Figure 2: Proportions of carbon embedded in the goods and services bought by UK consumers and businesses



Source: DEFRA, 2018

The Surrey Climate Commission believes that embedded emissions must be considered when carbon baselining the County and within the arising action plans.

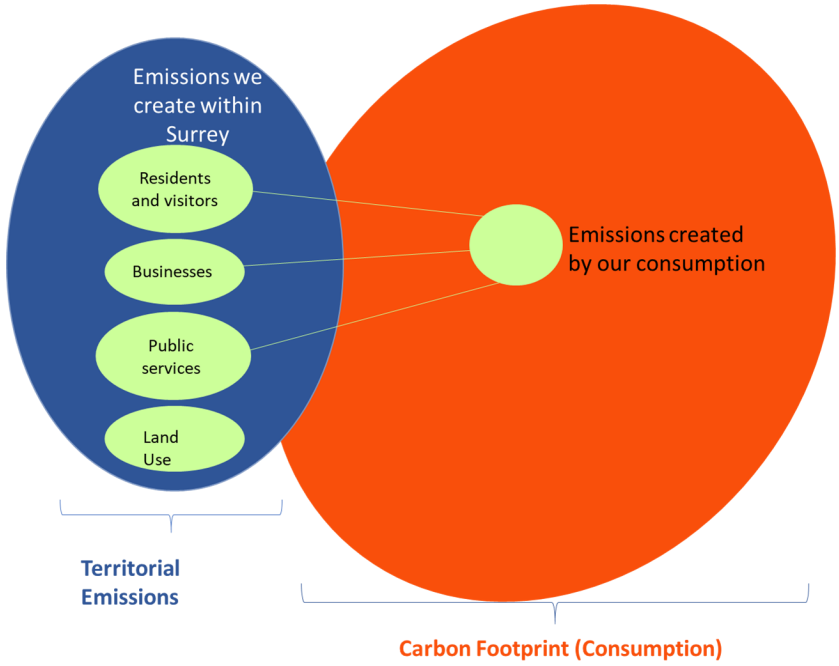
3.1 SURREY CARBON BASELINE

Structure

Carbon emissions are created by the way we live, work, travel and in what we buy. Businesses create emissions providing services and product and in the goods they purchase. Our public buildings and services, such as the NHS, all create carbon emissions. And how we use land both creates carbon emissions and sequesters them. In this baseline report we focus on the emissions that are directly created by all of us in the county (technically described as our territorial emissions) and in less detail we look at the estimates of Surrey's Carbon Footprint. Here we try to identify the emissions embedded in the goods and services bought by people and businesses based in the county.

Note that we are using the term "Territorial emissions" to cover not only the emissions produced from within Surrey but also those associated with Surrey end-users of electricity generated by power stations outside the county boundaries. So we are including in our 'territorial emissions' all the electricity emissions of consumers living and working in Surrey.

Figure 3: Visualisation of the baseline structure



3.2 TERRITORIAL CARBON BASELINE

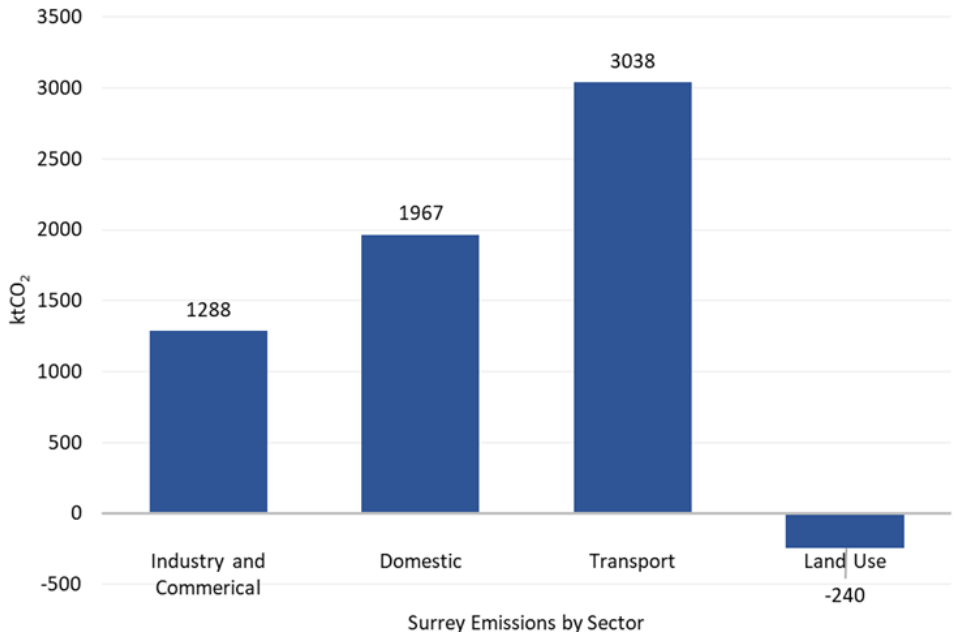
An Overview

The UK Government publishes carbon emissions on an annual basis and these are dis-aggregated to County and District/Borough Council Level. Full details of all carbon data available at a local level are provided by the UK government in its guide to Sub-National Consumption Statistics (BEIS, 2020a). This also provides references to more detailed methodologies. The data are openly available, offers a data series on CO_2 emissions from 2005-2018 and can be downloaded as an excel or CSV file.

From this data we find that Surrey emissions in 2018 were **6052.4 $ktCO_2$.**

So what do we find are Surrey's main areas of emissions?

Figure 4: Surrey Carbon Emissions by type (2018)

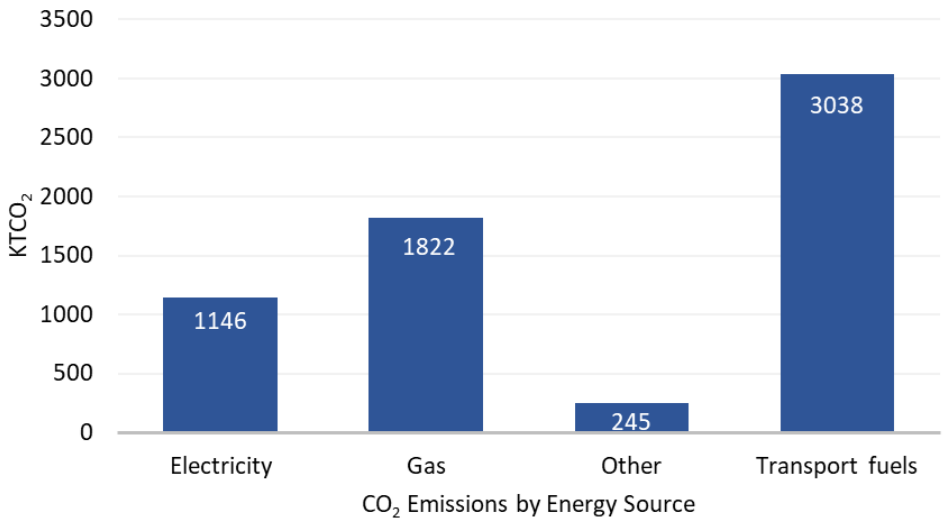


Source: ONS Local Authority CO_2 emissions estimates 2018 (kt CO_2)

This clearly identifies the scale of emissions we need to reduce to meet net zero ambition by 2050. It highlights the **enormous impact of travel and transport** across the county (Figure 3), now far greater than industry and commercial (which includes all the counties public sector emissions, such as council buildings, universities and public health facilities) and the impact from homes.

We are also able to look at the data in a different way, by the type of energy that is being used, and understand the emissions that this is creating. This is presented in Figure 5.

Figure 5: Surrey emissions by energy type (2018)



Source: ONS Local Authority CO_2 emissions estimates 2018 (kt CO_2)

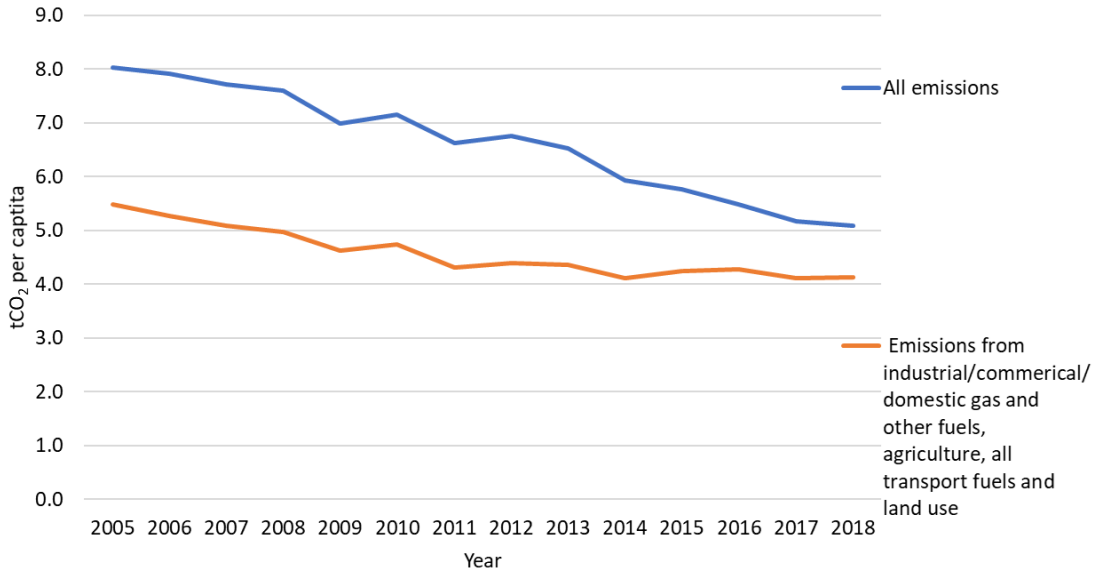
As we know, transport has the largest share of emissions in Surrey, but here we can see that the use of fuel such as petrol and diesel is nearly three times that of the emissions generated by the use of electricity. As we will explore in later sections, the majority of transport and travel emissions are from car journeys. Nationally we see increases in emissions from road vehicles, driven by increasing numbers of SUVs on the road and of van journeys.

Whilst only representing a small proportion of emissions across Surrey 'other emissions' comprise of a relatively small number of sites. These are properties within rural parts of Surrey that are 'off grid', where oil is being used for heating, and some industrial and agricultural companies using other fuels.

Gas, used to heat our homes, offices and commercial sites and in cooking food now represents the largest source of building based emissions in Surrey. Electricity continues to decline in emission levels, as the UK has rapidly 'decarbonized the grid' by using more energy from renewable sources, such as wind and solar. Reductions in electricity based emissions, along with increased energy efficiency by industry has driven the UKs carbon reduction.

Understanding the impact of reduced emissions from electricity is important when we start to look at change in emissions over time. In Figure 6 we take total Surrey emissions by year on the basis of an average per Surrey resident. Encouragingly we can see a strong decline from 8tCO2 per person in 2005 to around 5tCO_2 in 2018. However, when we remove emissions from industry and domestic buildings electricity usage we see a far less positive position. There has been no change in emissions since 2014.

Figure 6: Decrease in Surrey CO_2 emissions per person

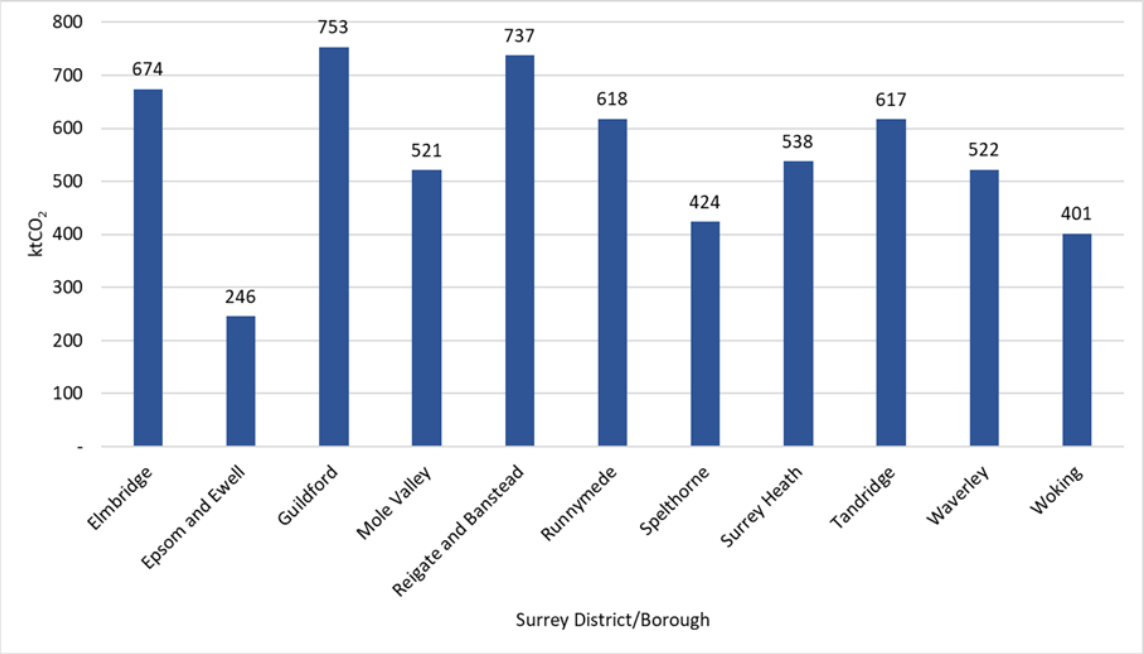


Source: ONS Local Authority CO_2 emissions estimates 2018 (kt CO_2)

But the UK ONS data does not just give us county based information. It can help us see what is happening at a District and Borough level. In the graph below (Figure 7) we can see that the emissions vary considerably between different areas.

In 2018 Guildford and Reigate and Banstead generated the highest levels of CO_2 emissions and Epsom and Ewell the least. Of course this will vary due to the number of residents, the type of businesses and the road networks, something we will consider later, but in real terms it provides us with information on where emissions occur.

Figure 7. Surrey emissions by District and Borough area (2018)



Source: ONS Local Authority CO_2 emissions estimates 2018 (kt CO_2)

We can also represent this in percentage terms to help build up a more visual picture of local carbon hotspots (Figure 6)..

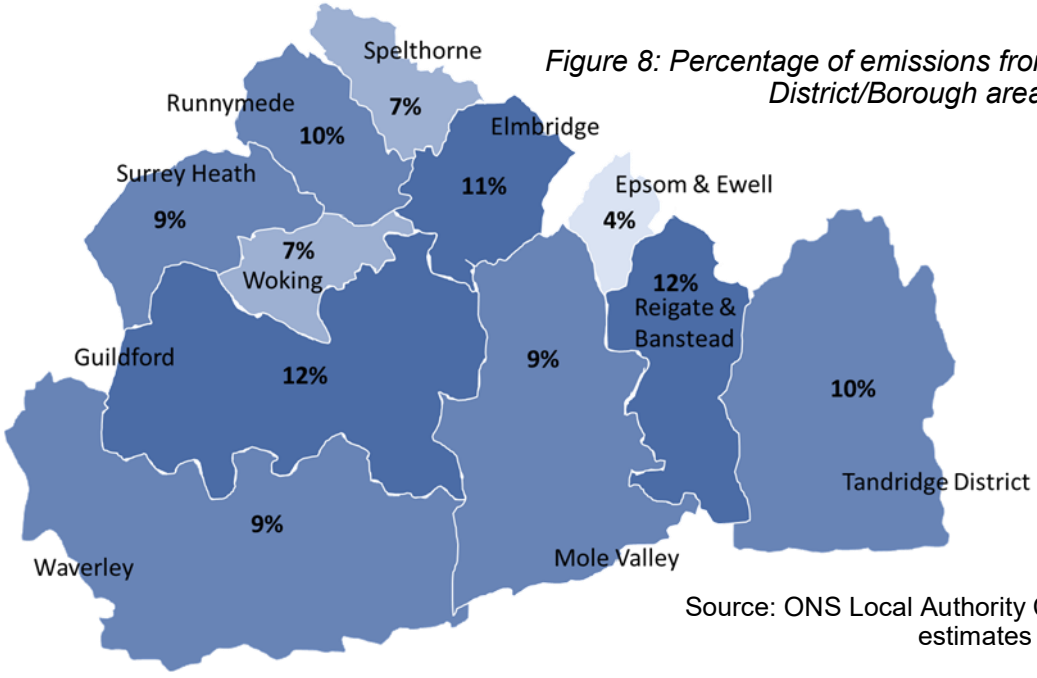


Figure 8: Percentage of emissions from Surrey District/Borough areas (2018)

Source: ONS Local Authority CO_2 emissions estimates 2018 (kt CO_2)

Whilst this information provides us with a baseline at the localized level, and is available for both energy type, as well as broad sectoral splits, it does not offer detailed insight into the elements that drive these emissions. It may also be seen as 'unfair', as districts obviously have different levels of population. To overcome this issue the ONS national statistics include a per person (per capita) allocation of carbon emissions,. This is calculated by taking the total emissions for each district and dividing it by the number of residents.

On this basis Runnymede and Tandridge residents emit the highest levels of carbon, both at 7.2t CO2 per person per year.

However, the Commission argue that this is too broad an allocation, failing to take into account local industry, road networks, and indeed the impact of renewable and low carbon energy, such as that found in Woking. The second part of this baselining report looks at key local issues at a community level and in more detail. This offers greater insight into the hotspots that need to be addressed.

3.3 TERRITORIAL EMISSIONS

Residents and Visitors (Housing and Travel)

People living in Surrey generate emissions from their homes, their personal travel and the products and services they buy.

The emissions from homes are recorded within the county carbon data, as are those journeys, or parts of journeys, undertaken within the county. All non-county UK travel is allocated to the regions through which their journeys are made.

The split between household energy and travel emissions has remained relatively constant over the last few years with around 46% being related to travel (ONS, 2020).

Carbon emissions related to air and sea travel are included within the carbon footprint but are difficult to allocate to personal travel by Surrey residents. Surveys of Heathrow and Gatwick Airports (2017, p.26,27) have demonstrated many of their visitors are local, with 2.8 million and 2.1 million Surrey resident travelling via Gatwick and Heathrow respectively in 2017. In the same year the estimated population of Surrey was 1.185 million (ONS, 2018), suggesting an average 4.1 flights per person per annum.

Surrey Homes

Homes in Surrey emitted 1967 $ktCO_2$ in 2018, of which 1385 $ktCO_2$ was from

Table 1: Estimated emissions from Housing by type– 2018/2019

	Total CO_2 emissions /annum (kt CO_2) based on EPC data 2019				DATA CHECK
District/Borough	Houses and bungalows	Flats and maisonettes	Mobile homes	Total	ONS LA (2018) kt CO_2
Elmbridge	239	33	0	272	253.9
Epsom and Ewelll	117	18	0	134	124.9
Guildford	194	24	2	220	225.4
Mole Valley	158	19	2	179	160.5
Reigate and Banstead	183	30	2	214	240.0
Runnymede	115	16	2	133	129.9
Spelthorne	129	22	1	153	144.2
Surrey Health	143	12	1	156	149.5
Tandridge	149	19	1	168	156.3
Waverley	223	22	0	245	227.2
Woking	130	23	0	153	155.3
Total	**1780**	**237**	**11**	**2028**	**1966.9**

Source: based on ONS, Accommodation by local Authority – Census 2011 and EPC data 2019

heating and 505 ktCO_2 from electricity. A small number of homes use other fuels, the highest emissions from this source being within Waverley, at 6.5%. Whilst many home owners have improved the energy efficiency of their properties major reductions in electricity based emissions are due primarily to the national decarbonization of the grid. There has been little decrease in the emissions from heating. Using EPC data and Census information on house types across Surrey it has been possible to estimate the emissions by house type by District/Borough (see Table 2)

Unsurprisingly, for a county with high areas of affluence most of the emissions are generated by houses and bungalows. When the data are normalized by the number of properties in each district (See Table 2) the maximum variation between districts of average emissions per property is 1tCO_2 per year.

Table 2: Accommodation type, by Local Authority (2011), average CO_2 emissions and affluence

Borough and District	Detached house	Semi-detached house	Terraced house	Flat, apartment, maisonette	Caravan or mobile home	No. dwellings	tCO_2 per property/year	LSOA mean deprivation score
Elmbridge	34%	26%	17%	23%	0%	55731	4.625	8.77
Epsom and Ewell	27%	36%	14%	23%	0%	20538	4.144	8.66
Guildford	34%	33%	14%	18%	1%	56080	4.056	8.13
Mole Valley	38%	28%	12%	19%	2%	36971	4.386	8.39
Reigate and Banstead	28%	30%	17%	24%	1%	57053	4.254	8.00
Runnymede	27%	33%	16%	20%	3%	34246	3.868	7.63
Spelthorne	20%	35%	21%	23%	1%	40887	3.601	7.00
Surrey Health	46%	25%	13%	15%	1%	34733	4.435	8.75
Tandridge	36%	28%	14%	20%	1%	34718	4.546	7.68
Waverley	42%	27%	15%	16%	0%	51545	4.391	9.00
Woking	32%	25%	20%	24%	0%	40652	3.907	8.18

Source: based on ONS, Accommodation by local Authority – Census 2011 and EPC data 2019

Whilst it has not been assessed in further detail the relationship of average emissions in a District or Borough and the mean Deprivation score of the area (10 being least deprived) would reinforce academic work by Minx et al (2013), clearing linking affluence with carbon emissions.

Key Points

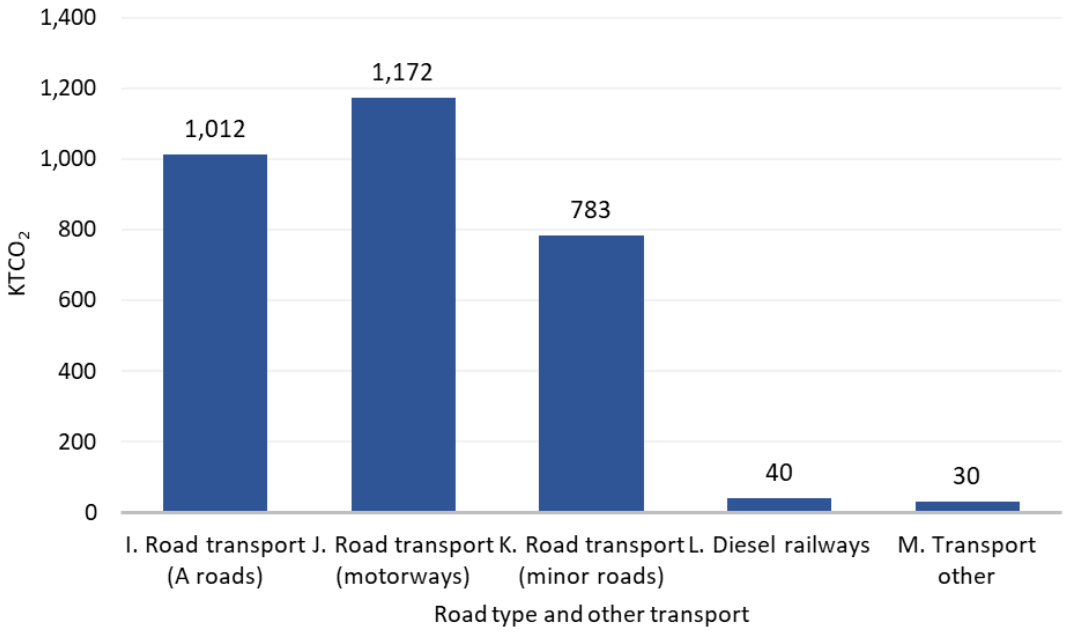
Heating is the greatest source of carbon from homes in Surrey

The data suggests that carbon emissions from a home increases with the affluence of the owner

Resident and visitor travel

ONS territorial data carbon emissions data for transport identifies 3116.7 $ktCO_2$/annum associated with Surrey (ONS, 2018). In this context transport describes 'traffic' movements – not just the transport of goods (NAEI, 2020). The greatest level of emissions are generated by traffic on Surrey roads, especially the A roads and motorways (See Figure 9).

Figure 9: Transport: Source of carbon emissions Surrey (2018)



Source: ONS Local Authority CO_2 emissions estimates 2018 (kt CO_2)

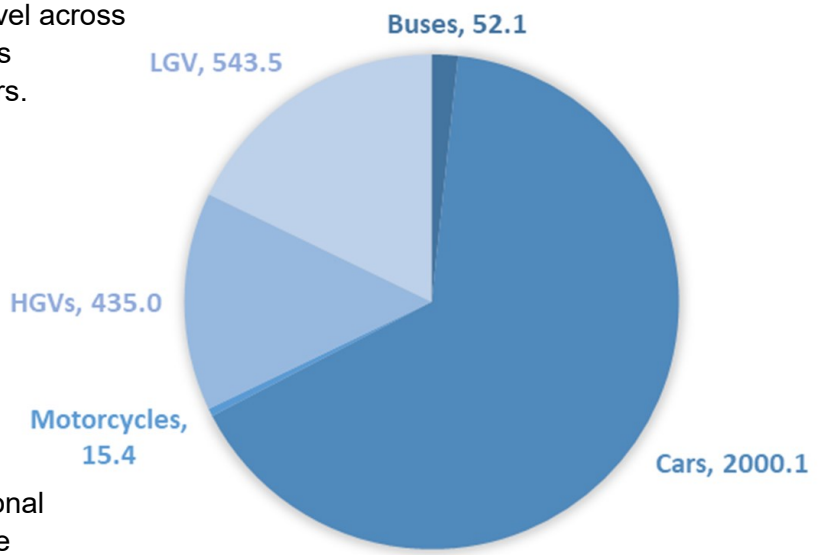
Whilst this data is useful in identifying where travel emissions are generated across the county it gives us very little insight into the vehicles that are creating them. It does not help us understand what vehicles are using the county's roads or how much of this is due to personal travel. To help understand this, we have looked at a number of data sources to try and give us an estimate of the emissions caused by different vehicle types (Figure 10).

What we find is that cars create the greatest proportion of road based emissions in Surrey. In fact we estimate that around 66% of emissions from all travel across the county come from the cars driven by residents and visitors.

Whilst we know that COVID has changed our travel patterns, we can expect that personal travel will continue to be a major source of emissions.

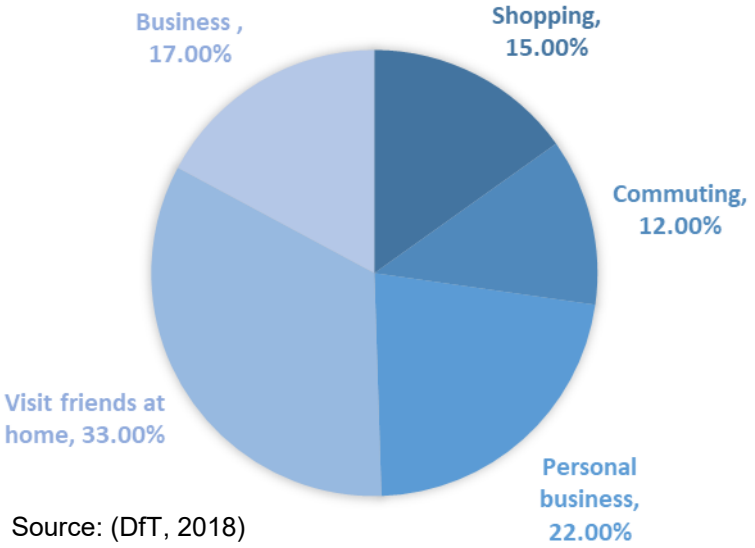
To try and understand the nature of personal travel we have looked at national data on why people undertake journeys (see Figure 11) and a more detailed analysis of travel to work.

Figure 10: Allocation of total emissions, Surrey road usage 2018 ($KtCO_2$)



Source: University of Surrey, based on ONS (2017), BEIS (2015), BEIS (2019) and DUKES (2019)

Figure 11: Why people make journeys in the UK (2018)



Source: (DfT, 2018)

National travel data research by the Department for Transport (DfT) identifies why people undertake journeys (Figure 11). Whilst we know that some commuting and business travel will be by trains and other types of public transport, much of the remainder will be undertaken by car. As we can see from the survey data, nearly a third of journeys are undertaken to visit friends at home.

How do Surrey residents travel to work?

How people to travel to work has, during the COVID pandemic, been dramatically shifted. In Table 3, we look at how people were travelling to work in 2011, the date of the last census. We know this will have changed but even as we return to a 'new normal' it is likely that some of the patterns will remain. As the data shows many people commute by train to work, especially from Elmbridge and Epsom and Ewell.

Many are walking to work or getting on their bikes. But the overwhelming method of getting to work remains the car or van. In every one of the Boroughs and Districts more than 50% of people drove to work. In Surrey Heath nearly 70% of people selected this form of transport.

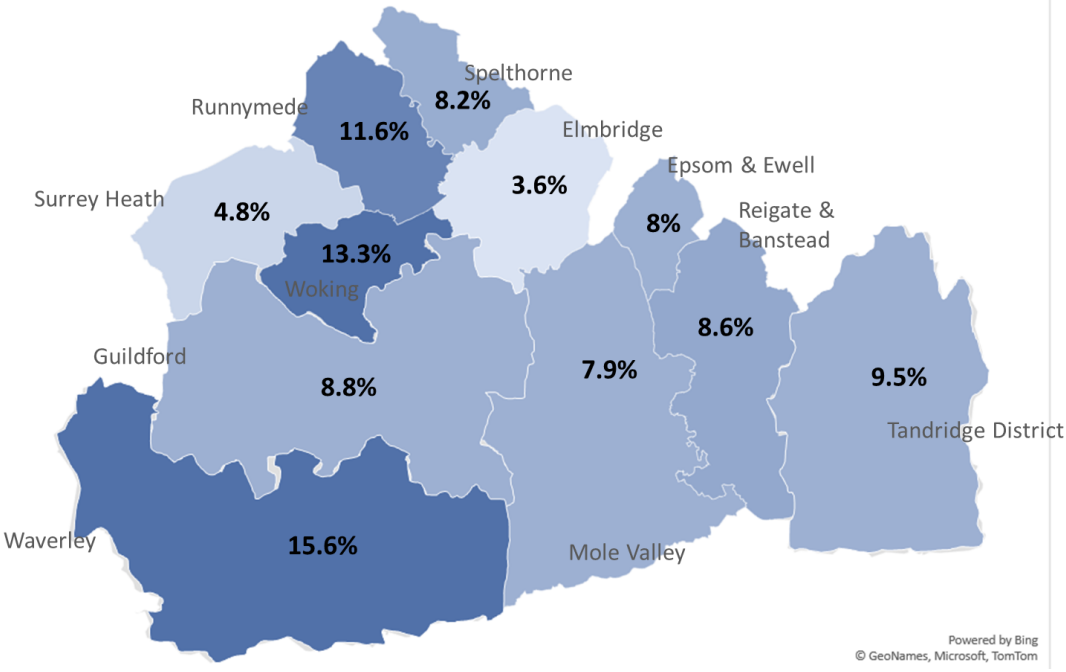
Table 3: How people travel to work in Surrey (Nomis, 2011)

Method of Travel to Work	Elmbridge	Epsom and Ewell	Guildford	Mole Valley	Reigate and Banstead	Runnymede	Spelthorne	Surrey Heath	Tandridge	Waverley	Woking
Work mainly at or from home	9.7%	6.0%	7.8%	9.7%	6.7%	6.1%	4.8%	7.7%	8.6%	10.2%	6.6%
Underground, metro, light rail, tram	1.0%	1.5%	0.3%	0.4%	0.5%	0.5%	1.3%	0.2%	0.5%	0.3%	0.4%
Train	20.8%	20.3%	11.3%	12.9%	15.0%	8.5%	8.0%	6.1%	18.1%	11.2%	15.9%
Bus, minibus or coach	2.1%	3.9%	3.4%	1.4%	2.9%	1.9%	5.2%	1.9%	2.4%	1.7%	2.3%
Taxi	0.3%	0.6%	0.2%	0.2%	0.5%	0.3%	0.2%	0.2%	0.3%	0.1%	0.4%
Motorcycle, scooter or moped	1.2%	1.3%	0.8%	0.9%	0.9%	1.1%	1.4%	0.7%	0.9%	0.7%	0.8%
Driving a car or van	52.2%	52.1%	57.3%	58.7%	58.5%	64.5%	65.9%	69.7%	57.6%	60.5%	57.8%
Passenger in a car or van	2.6%	2.9%	3.7%	3.5%	3.7%	3.8%	3.7%	3.7%	3.2%	3.8%	3.8%
Bicycle	3.2%	2.5%	2.6%	1.9%	1.7%	2.9%	2.7%	1.7%	0.9%	1.5%	2.7%
On foot	6.2%	8.2%	12.0%	9.7%	9.0%	9.9%	6.3%	7.3%	7.0%	9.2%	8.9%
Other method of travel to work	0.7%	0.6%	0.6%	0.7%	0.5%	0.7%	0.5%	0.8%	0.7%	0.7%	0.5%

Based on all usual residents aged 16 to 74 (Census, 2011)

Using the census data we can estimate the emissions created by Surrey residents as they travel to work. All modes of travel are incorporated in this information, including working from home, walking and bicycle, electric trains, cars, motorbikes and vans. Using DEFRA conversion factors this baseline research suggests that in 2018 commuting accounted for around 174ktCO_2, with Waverley and Woking accounting for highest commuter emissions at 15.6%.and 13.3% respectively (Figure 12).

Figure 12: Emissions created by Surrey residents travelling to work (%ktCO_2/annum)



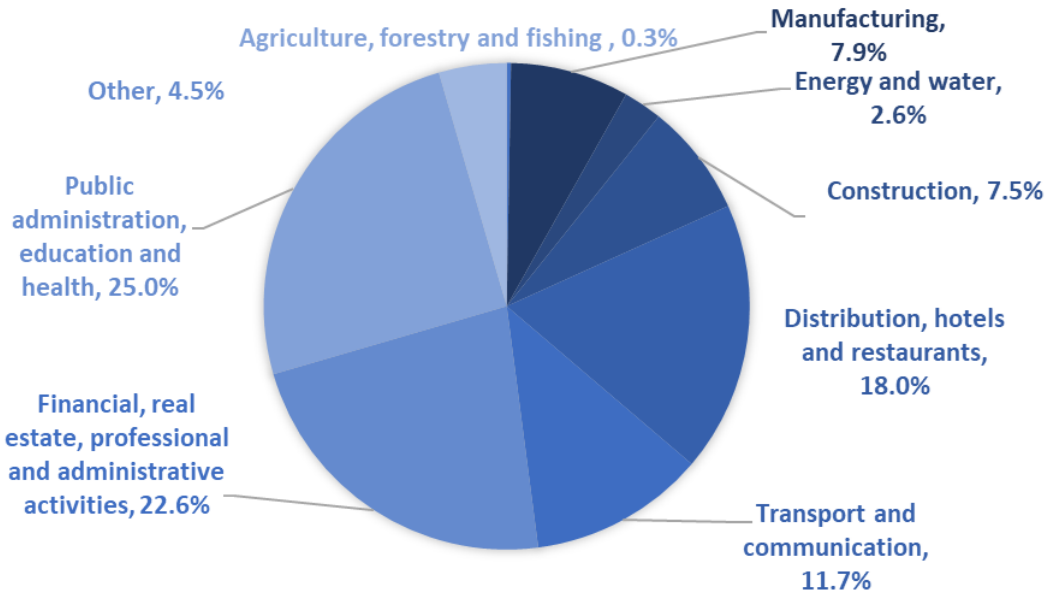
Source: University of Surrey, based on 2011 Census data and using DEFRA 2019 CO_2 conversion factors for business travel and freight.

Whilst a crude measure, we can extrapolate that if personal commuting accounts for around 174ktCO_2 per annum total personal travel is approximately 1435.5 ktCO_2/annum. This would suggest that around 46% of all Surrey travel emissions are generated by personal travel. Analysis of the composition of road transport types would suggest that the car usage represents the highest level of vehicle emissions across all road types in Surrey.

Personal travel may account for as much as 46% of all travel emissions in Surrey

We are able, again from 2011 Census data, build up a picture of how commuting varies by different work sector. Drawing on multiple sources of information we can see in Figure 13 that the sector generating the highest level of travel to work emissions are Public Administration, education and health. This is not surprising as the organisations are major employers across Surrey but it does indicate a major part of their carbon footprint sits outside their estate boundaries. The financial sector and hotels, restaurants and general distribution are next highest.

Figure 13: Percentage of Surrey $ktCO_2$ emissions derived from commuting, by sector (2018)



Source: (ONS, 2018; CENSUS, 2011, DEFRA, 2019)

In 2011, those travelling the shortest distance to work, with an average of 6.6.miles per day, were people employed in the agricultural sector. The highest average daily travel was undertaken by those in the construction sector at 22.0 miles (Nomis, 2011).

Key Points

Travel and transport are responsible for 50% of Surrey's carbon emissions, with around 66% of that due to car usage.

Road travel and transport accounts for 98% of Surrey travel emissions

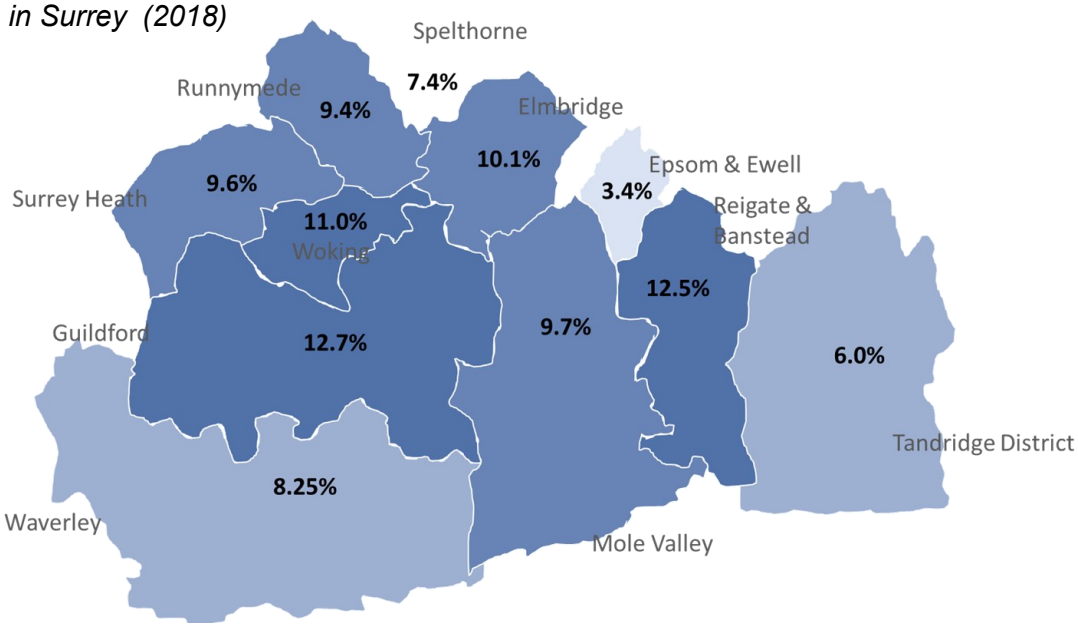
3.4 TERRITORIAL EMISSIONS

Industry and Commerce

1288 ktCO$_2$ was emitted by industry and commerce in Surrey in 2018

Industry and commercial includes public sector, defence, social service, other services, and undifferentiated goods and services-producing activities of households for own use. As well as giving us a total for Surrey the national ONS data can also offer us a view of how emissions from this sector differ between the Surrey Districts and Boroughs. (Figure 14).

Figure 14: The percentage CO_2 emissions generated by Industry and Commercial activity in Surrey (2018)



Source: Source: University of Surrey – allocation of national data

So are these emissions due to just a few large companies?

We were able to use data from NAEI (2020) to look at this question. It was possible to identify the large scale corporate point emitters and where they were based. In Mole Valley these were BT Plc (0.71 ktCO$_2$), Ibstock Brick (5.26 ktCO$_2$) and Wienerberger Ltd, another brick maker (2.53 ktCO$_2$). Digital Realty (UK) Ltd run backup generators in Reigate and Banstead, emitting 0.143 ktCO$_2$ and another in Woking (1.77 ktCO$_2$). These two sites have increased CO_2 emissions by more than 150% since 2017. Another large organisation, the Bank of America operating in Surrey Heath emitted 0.03 ktCO$_2$ and DEFRA in Runnymede, operating on two sites, 1.45 ktCO$_2$. It should be noted that there seems to be some variation in the recording of data, with large scale emitters Hanson Building Products in Mole Valley consistently being reported at no emissions and Anglo Beef Processors in Guildford, which were emitting 0.084 ktCO$_2$ in 2017, do not feature in the 2018 dataset,

although they are still operating from the same premises. In total whilst there are undoubtedly large emitters in Surrey, they only represented 11.7ktCO_2 of emissions in 2018.

We can look at this in more detail in the ONS information provided in their assessment of emissions by energy type (Table 4).Unlike Surrey homes, electricity is a greater generator of emissions than gas usage. There is also a significant level of emissions from other industrial fuels.

Table 4: Emissions from Industry/Commerce by District/Borough areas (2018)

	Total CO_2 emissions /annum (kt CO_2) , 2018					
District/Borough	Industry and commercial electricity	Industry and commercial gas	Large industrial installations	Industrial and commercial fuels	Agriculture	Industry and commercial Total
Elmbridge	61.9	56.0	-	10.2	1.4	129.5
Epsom and Ewell	22.5	18.6	.1	2.1	0.5	43.8
Guildford	81.1	63.3	-	13.7	4.2	162.3
Mole Valley	58.6	51.2	7.9	12.2	5.4	135.3
Reigate and Banstead	83.5	44.1	0.1	30.4	2.4	160.5
Runnymede	60.5	50.8	1.5	10.7	0.7	124.3
Spelthorne	47.3	27.0	-	14.4	0.4	89.1
Surrey Health	55.0	35.1	0.0	33.7	0.9	124.8
Tandridge	31.9	22.7	-	15.8	6.7	77.0
Waverley	44.0	38.8	-	16.6	6.3	105.8
Woking	95.0	29.0	1.8	8.4	0.8	135.0
Total	641.5	436.7	11.3	168.2	29.9	1287.6

Source: ONS Local Authority CO_2 emissions estimates 2018 (kt CO_2)

Whilst this data does provide direct information on the agricultural sector it offers very little granularity in terms of sector and area emissions. Using information business by sector by sub national level businesses numbers across the county were mapped. Data from BEIS on UK businesses numbers by sector were used to allocate an average carbon usage by business by sector using ONS information. This average was utilized to allocate carbon by business type, by area, across Surrey. Whilst, this clearly did not fully align with the sub-national carbon baseline data it does provide a useful guide. This exercise was undertaken for the measurement of both CO_2 and CO_2e (Tables 5 & Appendix 4, Table 8).

Table 5: Estimated Industry and Commerce (exc. public sector) emissions in Surrey by Sector and Borough/District ($ktCO_2$) 2018

Borough-District/Sector	Elm.	Epsom and Ewell	Guild.	Mole Valley	Rei.	Runny-mede	Spel.	Surrey Heath	Tandr.	Wav.	Wok.	Total
Agric., forestry & fishing	2.18	0.27	7.36	7.90	4.09	1.91	0.82	2.45	7.90	10.36	1.64	46.87
Manufacturing	75.92	28.28	84.85	64.01	75.92	58.06	52.10	61.04	61.04	98.25	61.04	720.52
Construction	10.33	7.21	10.94	8.55	14.24	7.33	8.43	7.21	10.39	10.51	5.93	101.06
Wholesale & retail trade/ repair vehicles	20.24	8.86	18.63	14.72	18.06	13.92	13.34	13.23	13.34	18.98	12.31	165.62
Transport and storage	30.14	15.63	25.67	18.98	26.84	19.07	102.69	23.44	23.44	18.98	26.79	361.65
Accom. and food services	4.04	2.09	3.39	2.60	3.97	2.53	2.45	2.89	2.09	3.75	2.82	32.64
Information and comms.	4.42	1.92	3.62	2.15	3.02	2.02	2.49	2.22	1.81	3.53	3.11	30.32
Financial and insurance activities	0.03	0.01	0.02	0.02	0.03	0.01	0.01	0.01	0.01	0.08	0.01	0.24
Real estate activities	2.21	0.65	1.74	1.15	1.33	0.97	0.74	0.82	1.12	2.21	0.85	13.78
Professional, scientific and technical activi-ties	5.75	1.96	4.17	2.86	3.58	1.78	1.67	2.33	2.30	4.45	2.79	33.62
Admin & sup-port services	5.41	2.11	3.86	2.96	4.25	2.42	2.34	2.56	2.87	4.11	2.70	35.59
Education	1.09	0.41	1.13	0.71	0.94	1.56	0.45	0.64	0.64	1.24	1.64	8.45
Human health & social	4.04	1.98	3.49	2.39	3.69	1.85	1.57	2.26	2.33	2.94	2.46	29.01
Arts, entertain-ment & recrea-tion	3.07.	1.12	2.32	1.72	2.05	1.35	1.23	1.51	1.56	2.58	1.51	20.01
	168.86	72.50	171.20	130.73	171.99	133.78	190.33	122.61	130.84	181.97	124.59	1599.39

(Source ONS and BEIS, multiple data sources 2019

These data do not provide a definitive baseline figure for each sector by District but they do allow us to identify potential emissions hotspots, here clearly displayed for the manufacturing sector, transport and storage, Wholesale and retail/repair of

vehicles and to a lesser extent construction. Manufacturing is shown to have a high impact in Waverley and Guildford, Elmbridge and Reigate and Banstead, whilst transport and storage is highest in Spelthorne.

Whilst the UK Government provides sub-national level carbon data as CO_2 emissions, this industry baseline work has also attempted to review CO_2e emissions to understand if under representation was occurring in any specific sector. The estimated CO_2e emissions, when compared to the CO_2 data in Table 3, would suggest that there could be considerable under reporting of emissions within certain sectors (see Appendix 4, Table 8). This research suggests that within agriculture, forestry and fishing and the manufacturing sector more than 80% of emissions are derived from gases other than CO_2. There would also seem to be a high proportion of none CO_2 emissions associated with the Finance and insurance services, but from a much lower base. On average other sectors appear to emit around 90% of their carbon as CO_2. All Boroughs/Districts are affected by this variation in emissions measurement.

Based on the number of businesses in the manufacturing sector in Surrey the allocation of the national data suggests that CO_2 emissions are 720.56 ktCO2 . However, when we look at CO_2e this is many times higher at 4656.49 ktCO2e.

Business Parks

This type of sector based analysis, whilst offering useful insight still provides only limited granularity. Business emissions, beyond those recorded directly for large emitters, are not easy to relate directly to specific local businesses or situations. There is no national, publicly available database of businesses that provides information on address, SIC code, or employee numbers, let alone energy use or fuel usage. We know that manufacturing in Spelthorne creates high emissions but it is not easy to identify who these companies are. The difficulty of creating a direct linkage was tested with an area the SCC were interested in exploring; business parks in Surrey. Many of these are high profile, visible and the site of many high tech, high value companies, especially the Surrey Research Park in Guildford. The business parks were identified by web search and emissions data captured in two formats. Business park websites were reviewed and several provided emissions information. Secondly, EPC data were checked for each of 31 individual building. Where emissions data were only available for one or two buildings but square meterage information was provided for others on the site, an estimate was made using an average CO_2/m^2 calculation. This work is shown in more detail in Appendix 4, Table 9. A summary of the findings are presented in Table 6.

Table 6: Estimated CO_2 emissions for Large Business Parks in Surrey (2020)

Borough/District	ktCO2 per year	Estimated proportion of known business park emissions
Elmbridge	0.018	+30% completed
Epsom and Ewelll	No business parks identified	
Guildford	4.22	+80% completed
Mole Valley	No business park identified	
Reigate and Banstead		No emissions data
Runnymede	0.73	+70% completed
Spelthorne	No business park identified	
Surrey Health		No emissions data
Tandridge	No business park identified	
Waverley	0.064	
Woking		No emissions data
Total	**5.03**	
Estimated % of industry and commerce emissions - Surrey	**0.39%**	

Source: business websites, MHCLG EPC Register

Key Points

Manufacturing still remains the largest emitting industry, with much higher CO_2e emissions than any other sector

The county has only a small number of large emitters

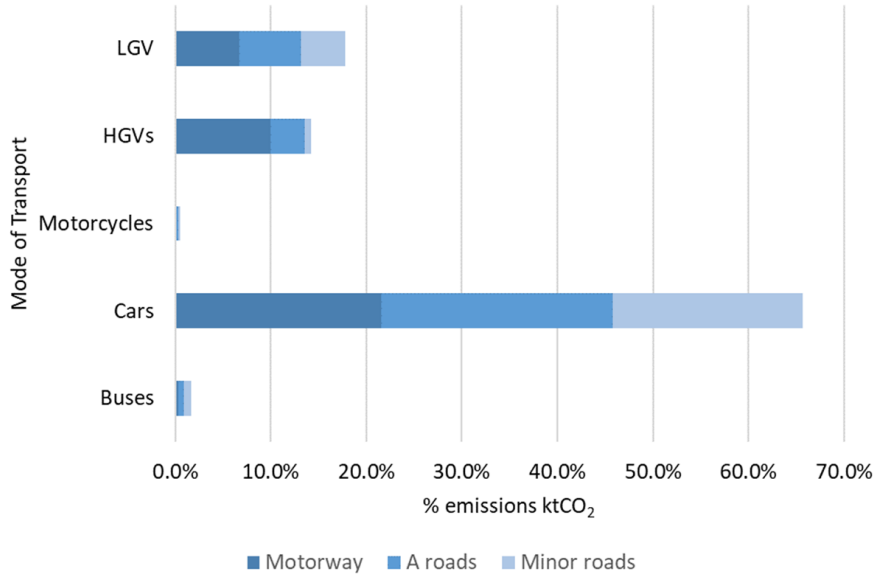
Industry and Commercial sector transport

This report only offers limited information on the movement of goods and services by business in Surrey. We saw earlier in the report that emissions from road travel and transport dominate the footprint of Surrey and a proportion of these are generated by companies managing the movement of goods and products and their staff travel. Nationally, around 17% of the travel people undertake is for business reasons, most of which is likely to be by road vehicle.

As we can see in Figure 15, Surrey does have a considerable flow of HGV goods vehicles, primarily on the motorway routes. Whilst some of these will be servicing Surrey companies, many more will be travelling through the county to other destinations.

The data also suggests a high number of lights goods vehicles are operating across all road types. We know from commuting data that many working in the construction sector are travelling over 20 miles, often by van to reach their building job. There is also a huge increase in vans operating as home delivery vehicles to service online shopping. Whilst outside the scope of this baseline research suggests that 'last mile' deliveries can be more carbon efficient than personal shopping trips but this is affected by the levels of rejected deliveries, returns and personal travel patterns (Edwards and McKinnon, 2009).

Figure 15: Estimated source of Surrey CO_2 road emissions 2017 ($ktCO_2$)



Source: University of Surrey, based on ONS (2017), BEIS (2015), BEIS (2019) and DUKES (2019)

3.5 TERRITORIAL EMISSIONS

The public sector

Public Sector data are included within the UK Government Emissions reporting for Industry and Commerce, which does not provide any disaggregation by sub sector. There is no one public, national or regional database that logs all the public estate within the county and its emissions. Data provided by the Cabinet Office does offer several sources of information on the central civil estate, including ministerial departments, Forestry Commission, and other provision as well as some information at a county council level (Cabinet Office, 2019b, 2019a).The research found Surrey County Council asset lists but these did not provide information on carbon performance. The NHS Trusts provided carbon data.

The data identified in this report is the most recent and publicly available for

Table 7: Public Sector Carbon Emissions in Surrey: Partial data (compiled 2019)

	Council own estate	Council leased &/ or procurement	NHS Hospital Trusts	Public Care/ Nursing Homes	University of Surrey	Total
		Data points within 2012-2019	Data points within 2012 to 2019	2018/2019	2020 unit data 2008-11 emissions est.	2018/2019
		tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
Elmbridge	1236	4022		153		5411
Epsom & Ewell	1465	909	14085	765		17224
Guildford	11773		11682	306	20544	44304
Mole Valley	1024	3134		306		4464
Reigate & Banstead	4939			459		13520
Runnymede	1392		8122	306		7807
Spelthorne	1279		6110	153		7695
Surrey Health	1279		6110	459		1432
Tandridge	1279					1738
Waverley	18033	1931		153		19964
Woking	7745					7898
Surrey CC	41738					
Total tCO_2e	93182	9996	46109	3366	20544	131458
Total $kcCO_2e$	**93.2**	**10.0**	**46.1**	**3.4**	**20.5**	**131.5**

Notes: One NHS Trust Hospital covers both Spelthorne and Runnymede, with annual emissions of 12219 CO_2e. For the purposes of this analysis we have assumed that 50% of the emissions are generated by each site and have been allocated to each borough (For further details see Appendix

For the purposes of this hotspot analysis CO_2 and CO_2e have been presented as CO_2e due to the mixture of metrics used by the different organisations. The UK government, in assessing public sector emissions, identified that the majority of these were CO_2

Surrey based public bodies. The information suffers from issues of old data, inconsistent units of recording, methodologies, information and time periods, all of which are provided in a variety of non-standardised presentation. The data available are primarily based on emissions from local authority occupied estate, with only some councils beginning to map carbon from their supply chains. As part of the Surrey County Council Climate Strategy there is an ambition for the County Council and Borough and Districts to ensure that they not only identify the emissions from their own premises but more widely from those that they own and lease or from their supply chains. This will offer much greater clarity. It will however still fail to capture all public emissions.

Council own Estate and procured services

The data provided for councils in Table 7 has been drawn from reports available on public websites. No data could be found for Spelthorne, Surrey Heath and Tandridge. To ensure they were represented the average of four similar sized councils, Elmbridge, Epsom, Mole Valley and Runnymede: 1279.17 tCO_2e. The information varies enormously by age of data, only limited standardization of material presented, including partial inclusion of leased properties and other none direct Scope 1-3 emissions. There is also variation in the units of measure, with some councils reporting only CO_2e and others, CO_2. which makes comparison and aggregation difficult. There is limited information on Council leased or procurement driven emissions (Scope 3 emissions).

The Commission is aware that having current carbon emissions data from each District is an action point in the Surrey County Council Climate Strategy. This is highly welcomed, especially if it provides standardized reporting. In addition to this we would strongly recommend the approach taken by Mole Valley District Council and Elmbridge Borough Council in developing data on Scope 3 emissions, primarily those of their supply network.

NHS Hospital Trusts

The Commission was supported by the NHS Sustainable Development Unit and offered access to their Sustainability Dashboard which was still in development at the time this work was being undertaken (NHS SDU, 2020). The dashboard was used to extra data relevant to Surrey Hospital services.

University of Surrey

The University monitors and reports carbon emissions on an annual basis and supplied this information to the Commission.

Care and Nursing Homes

The research suggests that Surrey has 22 publicly owned care homes and a review of literature provided very limited information on care home emissions, with only one report (Baddley, 2012) specifically looking at care home energy efficiency at a level of detail that allowed some extrapolation of data. This suggested a generalized care home

carbon emission footprint of 153 tCO_2 per annum. Whilst this was helpful further research was undertaken at a local level, in the attempt to provide a more granular baseline. The National EPC database was interrogated, with 15 private care homes randomly selected from across Surrey (Tomorrows Guides Ltd, 2020) and checked for EPC data. Currently a care home will need an EPC only on construction, sale or rental as a whole building and no certificates were registered. The final approach to identify specific Surrey data was to access care home websites (private premises) and where possible confirm the number of bedrooms available. Ten provided this information and using government data on minimum space, of 12 m^2 per room and 4.1 m^2 share of resident public space was estimated (assuming single person occupancy). None-communal or bedroom space was allocated at 1.5x bedroom and communal space. The resulting estimates clearly identified the variety in scale of homes – ranging from 10-90 beds and for the larger homes around emitting 56-82 tCO_2 per annum. Literature on private sector homes suggest bedrooms are up to three times the minimum government prescribed area, which would suggest higher home area and thus emissions.

Data on this sector, both public and private, is highly problematic and whilst this baseline has developed a standard allocation it is not suitable for more nuanced action.

And a final thought:

The public sector has not been fully explored or mapped, this research is just a start, but it does suggest, even if we remove the 10ktCO_2 generated from supply chains that it represents approximately 2% of the counties carbon emissions. This is consistent with UK governments national estimate.

Key Points

The public sector is likely to create between 2-3% of total Surrey emissions

The University and County Council estates represent the largest public emission points.

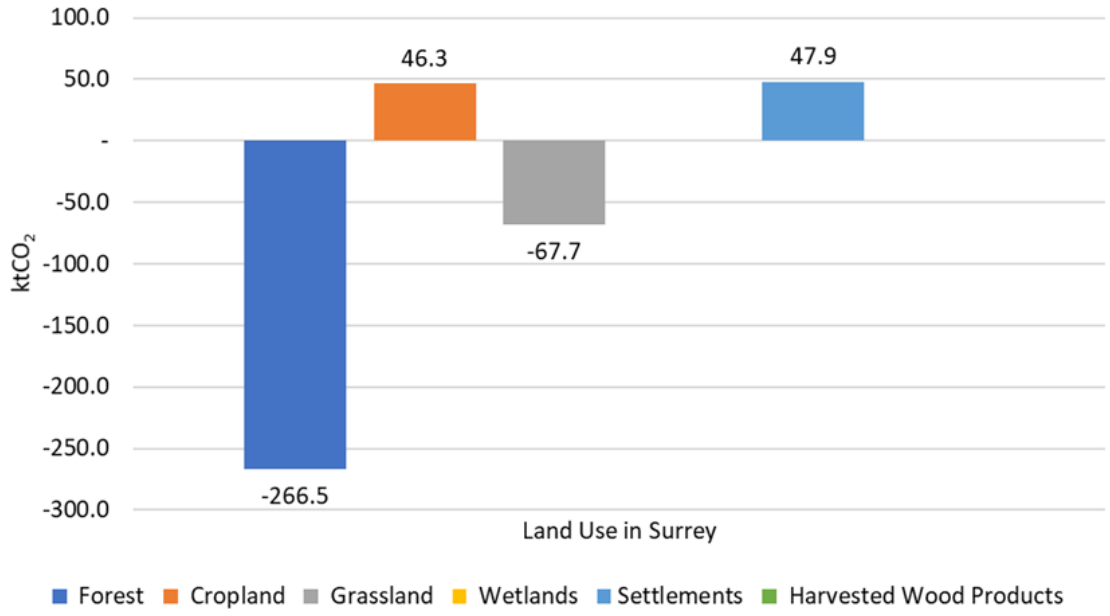
3.4 TERRITORIAL EMISSIONS

Land Use

In 2018, ONS expanded the information available at a local authority level to provide more detail on both positive and negative emissions from different types of land use (BEIS, 2020b). The data has been developed by a team at the Centre for Ecology & Hydrology and is described in the local authority datasets as Land use, land-use change, and forestry (LULUCF) (Clilverd et al., 2020). The methodological basis for this work is available: Mapping Carbon Emissions & Removals for the Land Use, Land Use Change & Forestry Sector.

In 2018 Surrey land was associated with removal of CO_2 emissions from the atmosphere (shown as a negative value) of -240.1 $ktCO_2$. The majority of this was provided by forest areas with additional removal associated with grassland. Cropland and settlement areas were net emitters of CO_2 (see Figure 16).

Figure 16: Surrey emissions, by land use type $ktCO_2$ (2018)

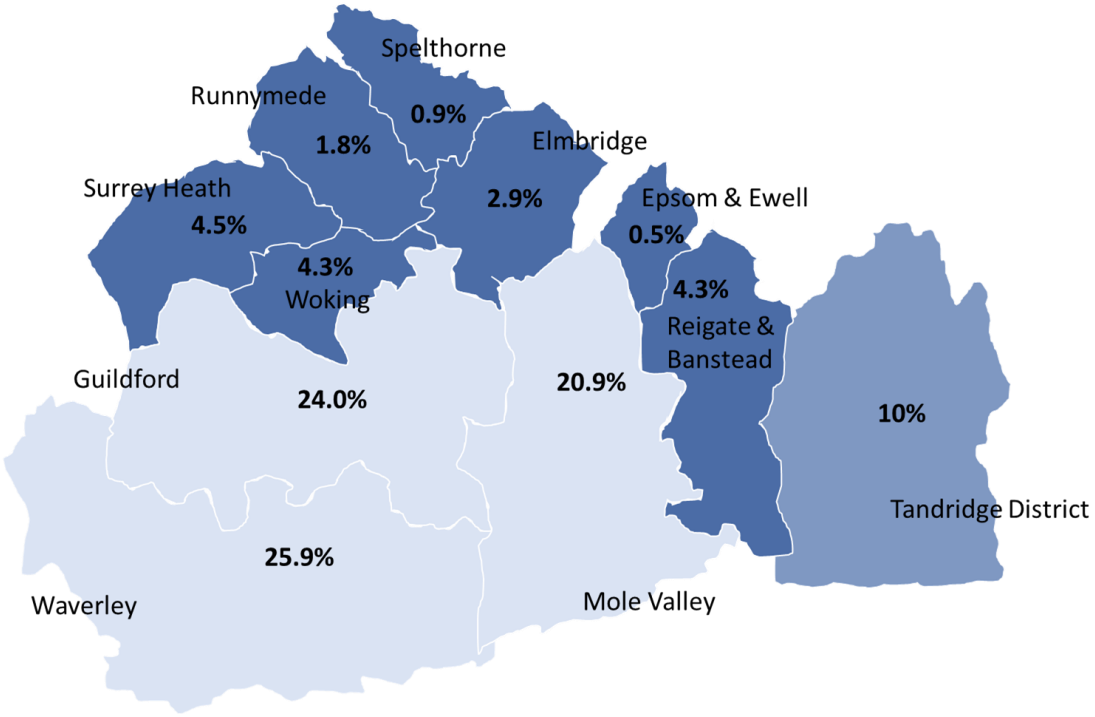


Source: ONS Local Authority CO_2 emissions estimates 2018 (kt CO_2)

When these data are examined at a local district/borough level it confirms that for each area the land provides some level of CO_2 removal .This is at it strongest in Guildford, Waverley and Mole Valley (Figure 17) due to the high levels of forestation and grassland able to offset the impacts of a higher level of settlement.

Tandridge, having a similar settlement, crop and grassland profile to the most 'carbon removing areas', has little sequestration due to limited forestation. There is no current reporting by ONS of carbon sequestration from wetlands or harvested wood products in Surrey.

Figure 17: Surrey emissions due to land use by District/Borough



This data, whilst offering greater insight than previous iterations of national emissions continues to have limitations for non-forestry assumptions. There is continued work to refine and expand the emissions data for different land use and land change scenarios.

Key Points

The land within all Districts and Boroughs sequesters more carbon than it emits

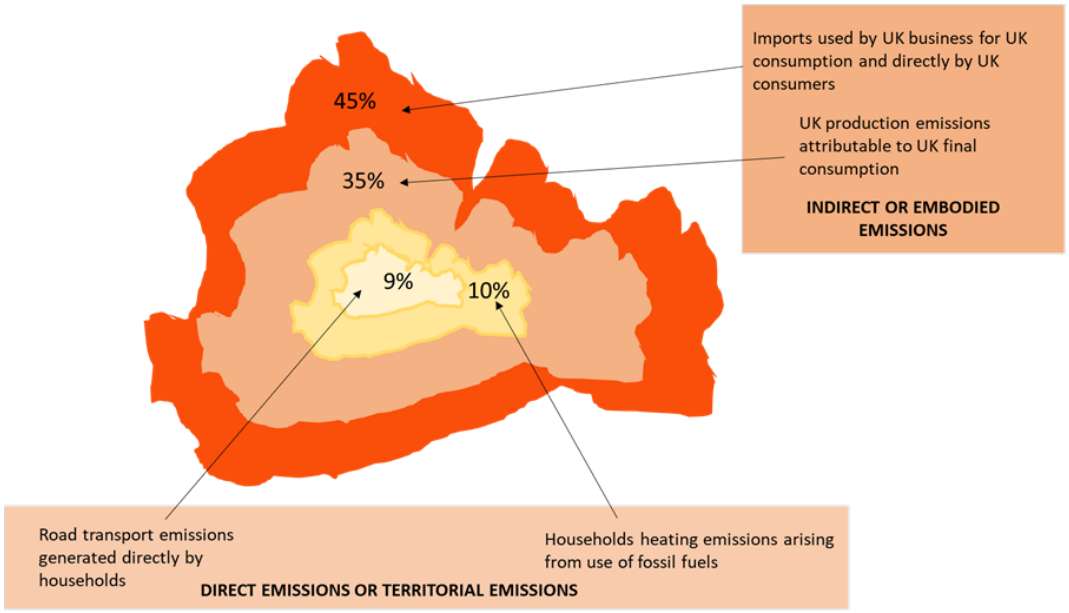
3.5 SURREY'S CARBON FOOTPRINT: CONSUMPTION DATA

All of the previous baseline data presented in this chapter has been focused on emissions created within the territorial boundaries of Surrey. The emissions have been produced by the businesses operating in the county, the people; their homes and local travel, the operation of the public sector and those passing through Surrey in vehicles. And of course, some of the carbon has been removed by the land itself.

However, these emissions are only a part of the CO_2 associated with the people and organisations of Surrey. As a country we manufacture and transport fewer goods, relying instead on importing products from the rest of the world. As this happens national carbon emissions tend to decline and the carbon associated with the goods we buy are incurred by other countries. This is described as offshoring our carbon. But the Commission believes that just as we must understand our territorial baseline to allow us to meet our long term carbon reduction goals we must also start to understand our carbon footprint.

The UK government publish a UK carbon footprint, the last version being updated in 2017 (DEFRA, 2018). This is comprised of both territorial (direct) emissions such as household road travel and heating and electricity and indirect emissions from imports used by UK businesses that are provided directly to UK consumers. In Figure 18, the split at a national level has been used to represent how this would look if directly transposed to Surrey. In this diagram UK production emissions attributable to UK final consumption have been considered as indirect or embodied emissions due to the limited consumer manufacturing base in the county. In reality some of these emissions would be generated within the county.

Figure 18: The national split of emission category visualized within Surrey (2017)



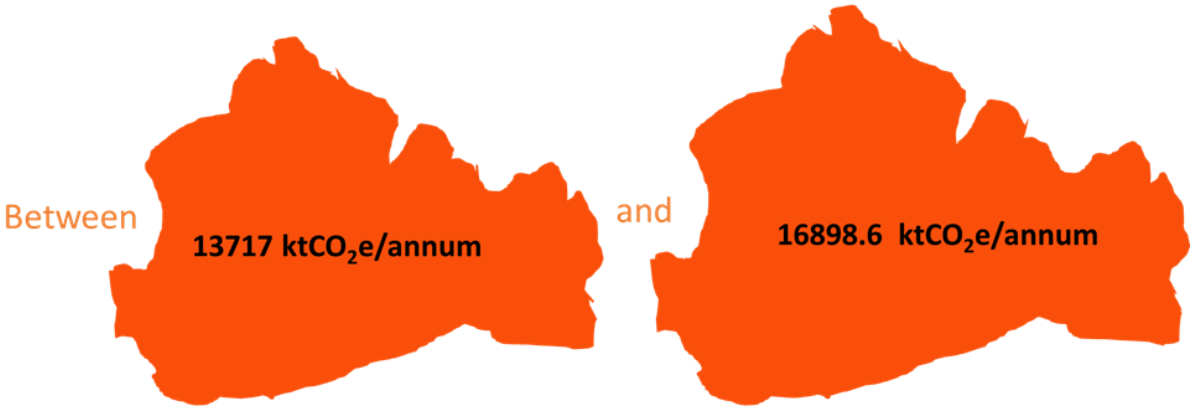
Source: emissions associated with UK consumption 2017, DEFRA/ONS (2018)

Whilst this offers a broad insight into the scale of the different categories of emissions calculated within the footprint, it does not provide us with a baseline. The National Footprint data is not currently available at a sub-regional level.

To create a baseline two approaches have been taken. Firstly a very simple allocation was undertaken on a very simple per capita basis. On the left of Figure 19 we can see that this provides us with a baseline of 13717 $ktCO_2$. However, this does not allow for the impact of affluence, an issue highlighted earlier and it is highly likely that this underestimates the carbon associated with Surrey's consumption. Therefore we have also looked at the work by Minx et al (2013) who combined both MRIO data with information on a variety of metrics linked to affluence such as education and linked this with postcode level information. This has been adapted and updated for Surrey and suggests that when the datasets are adapted to incorporate affluence the carbon footprint is 16899 $ktCO_2e$.

This offers a relatively crude measure of the Surrey footprint but would certainly suggest that it is at least twice the size of the territorial emissions.

Figure 19: Estimates of the carbon footprint of Surrey (2017)



Source: University of Surrey, based on data presented is based on greenhouse gas emissions associated with UK consumption 2017, DEFRA/ONS and University of Surrey, based Minx et al, 2013 with adapted greenhouse gas emissions associated with UK consumption 2017

4.0 MISSING DATA AND RESEARCH NEEDS

Data gaps

- Detailed property level carbon for Local Authority and other Public Sector assets, including those that are leased;
- high energy using private care organisations – e.g. care homes, social care and hospitals;
- business emissions generally poorly understood. Limited mapping of business by type;
- applying UK Land use change methodology at a local level and use to support planning.

Methodology

- Effective development of land mitigation tool based on LULCUF allocations at local level (long term UK Gov aspiration) – Surrey could be a pathfinder area;
- Effective allocation of carbon footprint to local level (ONS/Leeds + Minx).

SCC Working Group Support Information

- Requirement to provide more granular detail on target areas;
- Need to engage with Surrey County Council to align data with pathway;
- Support delivery, action and monitoring functions.

5.0 CONCLUSIONS

The transition to a net-zero carbon economy and society in Surrey, as in the rest of the UK and the developed world, will require major changes to many aspects of the way we work and live. To help understand the actions we need to take, and how effective they are, it is important that we have a baseline understanding of Surrey's carbon emissions at present.

This report from the Surrey Climate Commission offers an initial baseline carbon footprint analysis. It is intended to contribute to the essential base of knowledge and evidence required to enable the Commission and its members and partners to:

- identify a total carbon footprint for the county;
- monitor actions and change;
- demonstrate the success of interventions;
- identify hotspots: areas to focus policy development and implementation, and where 'rapid wins' might be possible;
- identify key pathways and projects for rapid decarbonisation;
- identify gaps in data, and areas where additional evidence will offer opportunities to improve the baseline.

We hope the baseline will prove valuable to members and stakeholders of the Surrey Climate Commission, across sectors in the county. We invite and welcome submission of further evidence from organisations, so that the baseline can be improved continuously and inform the development of the Commission's strategy and of climate action plans produced by our member organisations and partners.

Key Points: summary

- Land in Surrey stores more carbon overall than it emits;
- The public sector accounts for some 3% of emissions from the county. Most public sector estate emissions come from the County Council and University of Surrey;
- Manufacturing is the business sector with the highest emissions, but the county has few major emitters among its manufacturing enterprises;
- Most travel emissions come from road use, and personal travel accounts for some 45% of travel emissions;
- Heating is the main source of emissions from Surrey's homes.

Recommendations

We make the following recommendations in the wake of the research done in compiling the baseline study:

it should be used to inform the vision statement and 2021 action plan for the Commission, as it responds to the fast-developing climate policy scene in the UK and as it prepares to help make Surrey's contributions to the COP26 debate throughout the year.

It should be used by the Working Groups of the Commission to identify priority projects for development in 2021 and beyond, focusing on ‘quick wins’ and on ‘hotspots’ of emissions (for example, from travel and transport in the county), and on the challenge of changing consumption, given the scale of the county’s footprint when assessed from a consumption accounting perspective.

We should consider how to translate the analysis into accessible and engaging formats to help promote public debate and citizens’ engagement in climate action.

The issues raised here concerning data availability, evidence gaps and standardisation of reporting need to be kept in mind as strategic plans are developed, and could be the basis for funding bids to research councils and other funders of R&D for climate action at local level.

APPENDIX 1: OVERVIEW OF CLIMATE SCIENCE AND UK POLICY

The major impacts being identified through climate science create an imperative to reduce carbon emitting activities. This has led to policy demands to achieve net-zero carbon emissions within timescales ranging from approx. 2030 to 2050 (depending upon organization, government etc). This will require major changes to many aspects of the way we work and live and to help understand the actions we need to take and how effective they are it is important that we have a baseline understanding of Surrey's carbon emissions at present. Here we use of the general term 'carbon emissions' to mean the emissions of all recognized greenhouse gasses expressed in terms of their Carbon Dioxide (CO_2) equivalents based on the conversion factors for the global warming effect of the different greenhouse gasses over a 100 year timeframe published by the Intergovernmental Panel on Climate Change (IPCC). In developing this baseline we have considered not only the emissions that are directly emitted from homes, businesses, vehicles and land use within Surrey, but also the indirect carbon that is embedded in the products and services we buy.

A baseline carbon footprint will allow us to:

- identify a total carbon footprint for the county: allows us to monitor actions and change and to demonstrate the success of interventions;
- identify hotspots: areas to focus policy development and implementation, rapid win pathways and projects;
- gaps in data: opportunity to improve baseline.

State of climate science: IPCC,UK

The Intergovernmental Panel on Climate Change produced a Special Report in 2018 to highlight key issues for policy makers (Masson-Delmotte et al., 2018). They noted that the existing human made increases in global temperatures of around 1.0 degrees C would influence the climate for centuries or millennia to come. This would cause further long-term changes in the climate system, such as sea level rise well beyond 2100 (high confidence). It was highly likely that global temperature increases would reach 1.5 degreesC by 2030 – 2050 if they continue to rise at current rates.

Using models to project the impacts of global warming there are robust differences in regional climate characteristics between present-day and global warming of 1.5°C, and between 1.5° C and 2°C. These differences include increases in:

- mean temperature in most land and ocean regions (high confidence);
- hot extremes in most inhabited regions (high confidence);
- heavy precipitation in several regions (medium confidence);
- and the probability of drought and precipitation deficits in some regions (medium confidence).

What is clear is that most adaptation needs will be lower for global warming of

1.5°C compared to 2°C (high confidence). By keeping to 1.5°C we will have lower impacts on species loss and extinction, lower impacts on terrestrial, freshwater and coastal ecosystems, reduced risks to marine biodiversity, fisheries and to be able to retain more of their services to humans (high confidence) compared to 2°C. Climate-related risks to health, livelihoods, food security, water supply, human security, and economic growth are projected to increase with global warming of 1.5°C and increase further with 2°C.

Whilst these issues may have felt remote or futuristic only a few years ago we are now seeing many of these impacts in our own county. Very dry conditions in April 2019 saw two major fires on Chobham Common, with over 100 acres of heather and trees destroyed (Editorial-team, 2019). In the previous summer four major heatwaves were responsible for nearly 900 additional deaths in the UK (Public Health England, 2018). Flood alerts have become common and in 2014, after one of the wettest winters on record, 1000 homes flooded as the Thames burst its banks (Dixon and Carter, 2014).

Pathways limiting global warming to 1.5°C with no or limited overshoot would require rapid and far-reaching transitions in energy, land, urban and infrastructure (including transport and buildings), and industrial systems (high confidence). These systems transitions are unprecedented in terms of scale, but not necessarily in terms of speed, and imply deep emissions reductions in all sectors, a wide portfolio of mitigation options and a significant upscaling of investments in those options (medium confidence) (Masson-Delmotte et al., 2018).

UK Committee on Climate Change: Net Zero report (May 2019)

The Committee on Climate Change (2019) in their report recommended a new emissions target for the UK: net-zero greenhouse gases by 2050. They stated that this target would deliver on the commitment that the UK made by signing the Paris Agreement and that the target could be delivered by known technologies and improvements in people's lives. Their analysis confirmed that this could be delivered within the expected economic cost that Parliament accepted when it legislated the existing 2050 target for an 80% reduction from 1990. However, they were clear that existing policy was insufficient to meet existing targets, and it would require new, stable and well-designed policy to meet the net-zero goal.

In addition to offering guidance to government on the policy leadership role required, the committee highlighted the importance of cities and local authorities in carbon reduction. They are well placed to understand the needs and opportunities in their local area, with important roles on transport planning, including providing high-quality infrastructure for walking and cycling and the provision of charging infrastructure for electric vehicles. Local authorities also have a regulatory requirement to ensure that new housing developments are designed for access to public transport. Local government can

implement clean-air zones that discourage use of polluting vehicles to improve health outcomes for people who live and work in the area. Despite offering these important functions the committee questioned whether local government had sufficient resources to contribute strongly to reducing emissions (Committee on Climate Change, 2019).

UK Government analysis: Net Zero policy

"The government will only be able to meet its target of reducing greenhouse gas emissions to net zero in the next 30 years if it is willing to fundamentally change the way it operates and its policy priorities"

Sir Ian Boyd, DEFRA Chief Scientist (Smith, 2019).

The UK government accepted the findings of the Committee on Climate Change report and published its response, Leading on Clean Growth, in October 2019. This outlines the areas that government is currently developing policy or embedding existing approaches into carbon reduction:

1. Embed net zero policy across all levels and departments of government, with strong leadership and coordination at the centre.

- Transport Decarbonisation Plan is under development to step up the pace of progress towards a cleaner, more sustainable and innovative transport network;
- strengthen the cross-government effort to deliver clean growth and ensure that our clean growth objectives are embedded throughout all of our policies on homes, business and industry, transport, agriculture, forestry, land use, waste and power. Implement enhanced governance arrangements;
- HM Treasury will take forward the world's first comprehensive review by a finance ministry into both the costs and the benefits of transitioning to a net zero economy. The review will consider how to achieve this transition in a way that works for households, businesses and public finances, as well as how we can ensure that this is compatible with our plans for a thriving and competitive economy.

2. Make policy business-friendly, with incentives that support businesses to innovate and switch to low-carbon solutions.

- e.g. £2 billion to support decarbonisation in a range of sectors – including investment in hydrogen and low carbon technology in industry, electric vehicles and charging infrastructure, and projects to accelerate rollout of carbon capture and storage technology;
- streamlined Energy and Carbon Reporting framework to incentivise energy efficiency and emissions reduction in large businesses;
- to deliver a package of measures that will improve business energy efficiency by at least 20% by 2030 e.g. ESOS, CCA;

- an export strategy supporting clean growth trade and investment as a priority for the UK government.

3. Putting people at the heart of policy design: this includes increased consultation, public awareness raising and support for energy reduction, new product standards, increased producer responsibility and a new National Food Strategy

4. Supporting international increases in ambition:

A) hosting COP 26 in 2020 and promoting five key aims:

- to drive international cooperation on clean energy including innovation in technologies like smart green grids through a second phase of Mission Innovation;
- making zero emission vehicles cheaper than petrol and diesel and speeding up progress on low-carbon transportation;
- to harness the power of the markets to deliver a rapid transition and to protect nature. We will need to meet and move beyond the current $100 billion target;
- to help every part of society, and especially the most vulnerable, adapt and become more resilient to the effects of climate change by turning the Call for Action on Adaptation and Resilience, which was launched at the UN Climate Action Summit last year, into tangible action on the ground;
- to massively ramp up our efforts to protect and restore the natural ecosystems (Goldsmith, 2020).

B) doubling the UK climate finance commitment to £11.6 billion from 2021 to 2025

C) pledged to contribute £1.44 billion to the Green Climate Fund over the next four years

D) promoting global alliances to encourage clean growth, such as the Powering Past Coal Alliance

The UK Prime Minister has committed to "build back better and build back greener" post COVID crisis (Johnson, 2020).

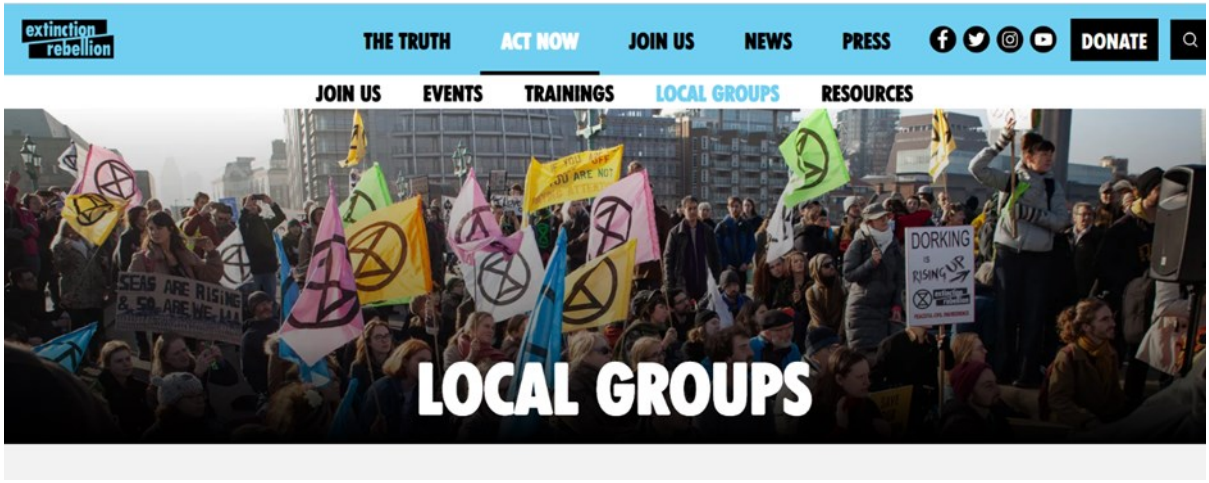
The Committee on Climate Change (2020) have also made key recommendations to government in the Progress Report suggested that there were measures that should be adopted as priority post COVID. These are:

- Low-carbon retrofits and buildings that are fit for the future;
- Tree planting, peatland restoration, and green infrastructure;
- Energy networks must be strengthened;
- Infrastructure to make it easy for people to walk, cycle, and work remotely;
- Moving towards a circular economy.

Rapid Decarbonisation

Analysis by Tim Jackson of the Centre for Understanding Sustainable Prosperity at the University of Surrey, of the UK carbon budget has identified that just setting a target date for zero carbon does not signify the country will within the budget. More importantly this must be aligned with an emissions pathway. His findings suggest that for 'reduction rates high enough both to lead to zero carbon (on a consumption basis) by 2050 and to remain within the carbon budget require absolute reductions of more than 95% of carbon emissions as early as 2030' (Jackson, 2019). Therefore his paper recommends setting a UK target for net zero carbon emissions by 2030 or earlier.

This sense of greater urgency is supported by the findings of Anderson et al (2020). Their work identified that the current UK mitigation plans and policies enacted to achieve the 'well below 2 degrees' of the Paris Agreement are half those needed to meet the Paris targets.



Source: (Extinction Rebellion, 2019)

"I am here because I believe there is no point having an education if there is no future …." Ivy, 14, from Surrey

"It is not us that did this – we are only 14 – but no one else is doing anything about it and it's our future, so what choice do we have?" her friend, Arissa.

(Taylor, 2019).

APPENDIX 2: SURREY COUNTY COUNCIL COMMITTMENTS

Surrey County Council declared a climate emergency in July 2019 and subsequently launched a Climate Change Strategy (Surrey County Council, 2019). This supports existing work such as their New Tree Strategy, a forthcoming consultation on a Land Use Strategy, and local action plans. The Climate Change Strategy has several key ambitions that relate directly relate to carbon reduction:

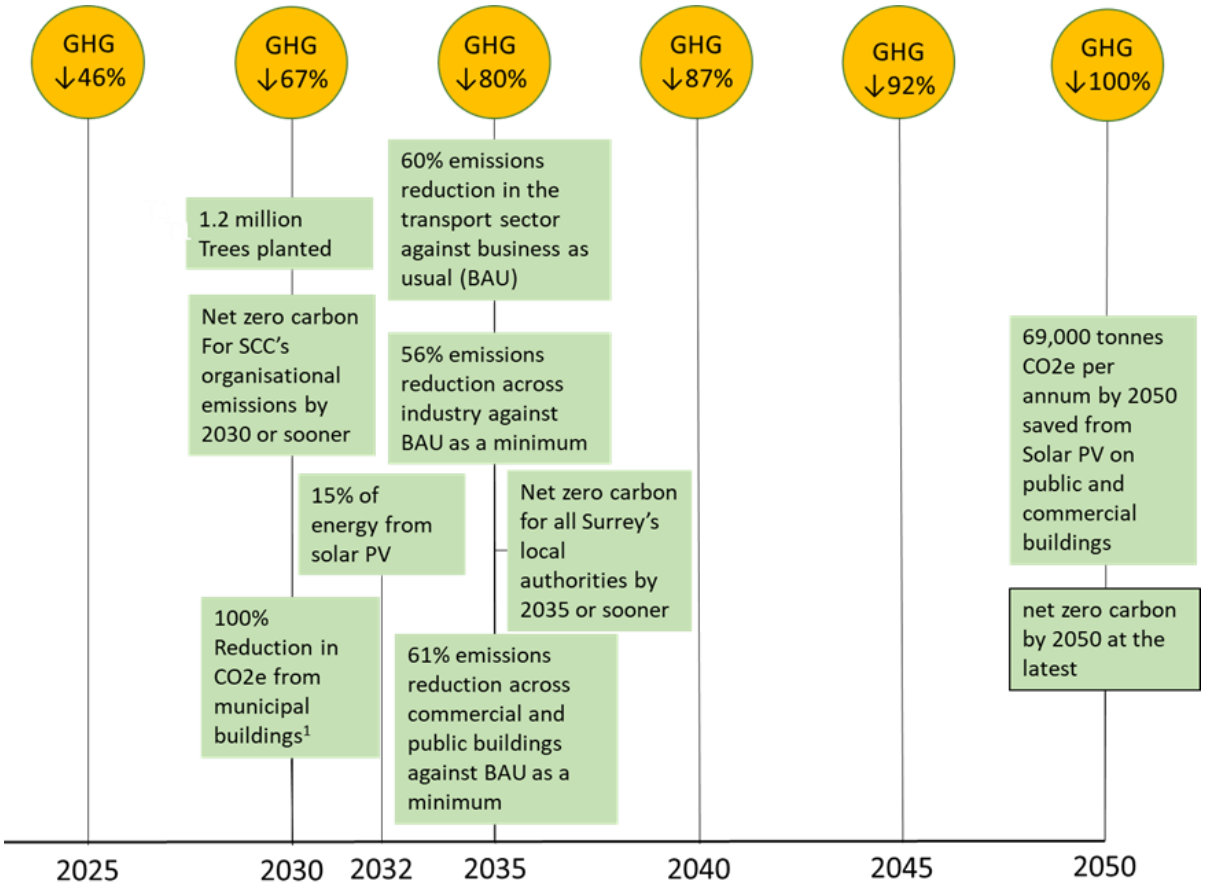
An overarching aim to achieve net zero by 2050 or earlier

1. **Organisation emissions:** achieve net zero by promoting sustainable practices across operations, estate and vehicles.
2. **Transport** – deliver a public active (walking/cycling) transport system across the county
3. **Energy Generation** - lead renewable energy generation expansion and bring low carbon heating to surrey homes via smart, decentralized systems
4. **Housing and Planning** - to create low carbon homes for residents
5. **Building and Infrastructure** – transition to zero carbon built environment by lower operational use, increased renewable energy and reduced embodied carbon in construction
6. **Waste, Resources and Circular Economy** – No direct carbon commitment but increased reuse, composting and recycling may result in increased carbon emissions.
7. **Land Use and Food Systems** – develop a framework for Surrey to support national targets
8. **Industry and Green Economy** - decarbonize major sectors, invest in clean technologies and industries

However, the strategy accepts that despite adopting all current cost-effective or technically viable options there will be a -36% gap in carbon reduction. This will require innovative or 'stretch' options to be implemented to achieve net zero. The county council, following the publication of the strategy, have committed to producing costed delivery plans for each of the actions, outlining the expected costs, ownership and any specific key performance indicators (KPIs) for monitoring.

Currently five of Surrey's borough and district councils have also responded and declared climate emergencies. Elmbridge, Guildford, Mole Valley, Waverley and Woking councils have set a target of becoming carbon neutral by 2030. Epsom and Ewell does not have a target date. Whilst SCC note in the strategy that all local authorities are in the process of baselining their estate the current carbon data for many borough and district councils is dated and in several cases unavailable publicly. Two councils, Elmbridge and Mole Valley have commissioned the Carbon Trust to support their baseline. This has included Scope 3 supply chain emissions, an area identified by Surrey County Council as within their organizational impacts.

Figure 20: Surrey County Council Carbon Pathway and Targets (CO_2e)



(Source of information: Surrey Climate Change Strategy, 2019)

APPENDIX 3: DETAILED METHODOLOGY

This baseline study has utilised data to achieve three overarching aims:

to ensure it has ***maximum compatibility*** with national statistics (e.g. BEIS/ONS) and to work with other Climate Commissions (and similar bodies) to develop a standardized approach. This aim fully aligns with the carbon baseline approach adopted by Surrey County Council in their Climate Change Strategy (2019).

that it can provide an overview of ***maximum GHG inclusion*** of GHGs and scopes (inclusion of consumption and other 'missing' emissions). The intention of this is to indicate the scale of any gap between this and the maximally compatible Surrey carbon data to aid planning, actions and expected timeframes to net zero

data selection will be on ***maximum disaggregation*** to give information on the contribution of, and variation in, sources of carbon emission across Surrey's Districts, main emitters, local and County Council emissions etc. We anticipate considerable 'incompleteness' in this and we will need to be guided by the available and new data that we can generate on sources and whether there is focus on CO_2 or CO_{2e} etc.

Overview of sources for carbon footprint baseline study

An initial review of material was undertaken in November-December 2019 which identified information on methodologies used for place based carbon baselining, national emissions data sets and reports, local carbon data, academic papers on specific emissions issues, and a wide range of background information. The materials were logged to indicate date of issue and with website links to allow easy access for further research. The materials were consolidated into 5 categories.

- Carbon Foot-printing methodologies at a sub-national level;
- National databases offering sub national information;
- Surrey specific emissions data;
- General information;
- Projections.

The data have continued to be updated as the baselining work has been undertaken and should provide a useful source of information for other researchers.

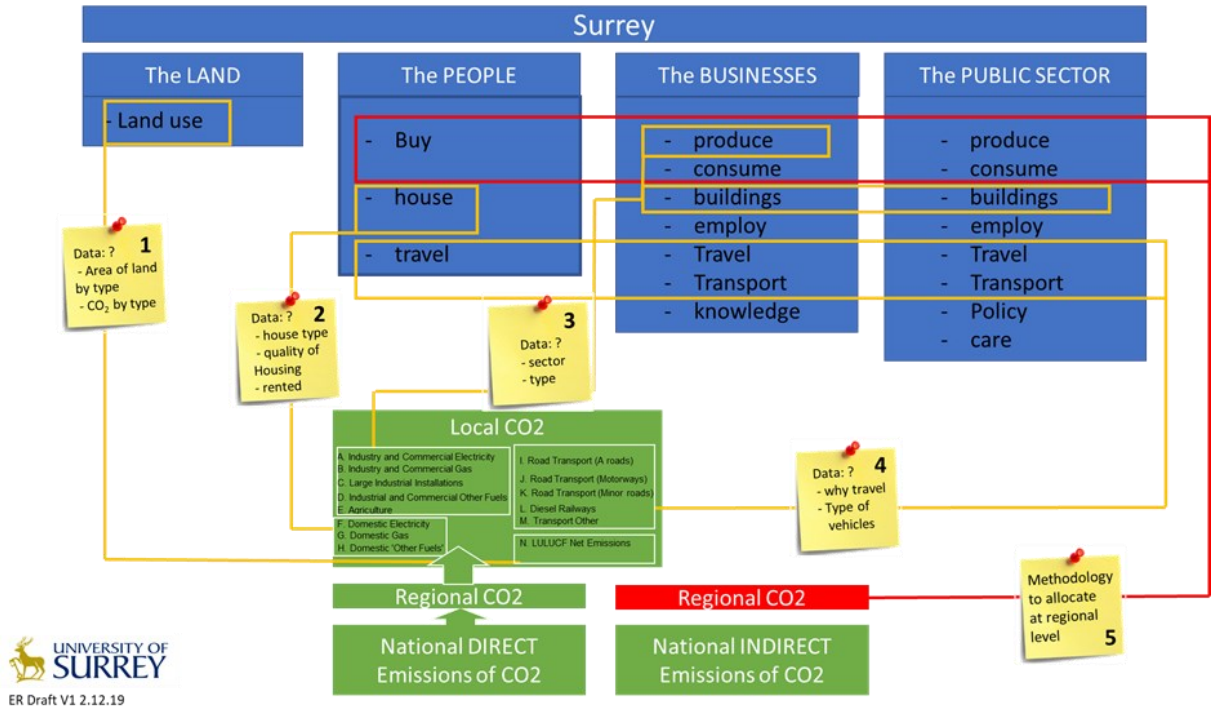
Overview of assumptions, methods and analysis

This baseline study has been underpinned by a determination that data must align the territorial and embodied (consumption) carbon data provided by the UK government. The rationale for this position is that the data are likely to continue to be, updated on an annual basis, which is critical for providing both the sub-national baseline and also regular updates on performance. Information on territorial emissions, at a local authority level, is provided by government only as carbon dioxide emissions and has been approved as an official ONS statistic. It is available at both country and district level. Technical

guidance is provided and the methodology used to provide the data will continue to be reviewed and when necessary refined. It is important that all organisations can access this overarching data easily and that it is at no cost. The UK Sub National Consumption statistics provide information on four main types of fuel categories. A similar approach has been taken to UK consumption data, also known as the UK's carbon footprint. Again it is a dataset provided by ONS at a national level, but based on multi-regional input output analysis. It is only available at a national level and ONS confirmed they do not have a methodology currently for providing this at a sub national level. Carbon is presented in annual briefing reports as CO_2e data but CO_2 datasets are also available.

A visualization of this process was provided to the SCC (Figure 21).

Figure 21: Research Schematic



The initial carbon foot printing work, undertaken by the Commission, used 2017 baseline data and an initial Surrey Baseline Presentation was provided to Commission members and Surrey stakeholders in July 2020.

For this final report, this work has been updated using UK National 2018 data (BEIS, 2019). This ensures full alignment with the baseline projections used to generate the Surrey County Councils climate projections and targets (Surrey County Council, 2019).

FIND OUT MORE

Surrey Baseline Presentation July 2020

https://www.surreyclimate.org.uk/news/

From this overarching data this research and report has attempted to drill down in more detail into the high level emissions to being to offer a more detailed view of local issues and where possible to highlight hot spots and/or data gaps.

It is clear from this research, and from the work of others, that multiple national reporting formats have created discrete UK carbon data sets. Information may be held in different measurement units and carbon formats and variation in methodologies makes direct comparison between them difficult. The ONS information, whilst providing technical guidance on the methodologies used for allocation, does not offer access to the datasets that have been used to compile statistical releases. Whilst this research has attempted to align more detailed local or sector analysis with ONS datasets there is clearly variation in results, due potentially to assumptions made in carbon allocations and base data. Therefore use of the further disaggregated local carbon information should be to support further action rather than act as definitive baseline data.

APPENDIX 4: ADDITIONAL DATA

Table 8: Estimated Industry and Commerce (exc. public sector) emissions in Surrey by Sector and Borough/District ($ktCO_2e$) 2018

Borough-District/Sector	Elm.	Epsom and Ewell	Guild.	Mole Valley	Rei.	Runny-mede	Spel.	Surrey Heath	Tandr.	Wav.	Wok.	Total
Agric., forestry & fishing	12.14	1.52	40.97	44.01	22.76	10.62	4.55	13.66	44.01	57.67	9.11	261.02
Manufacturing	490.66	182.80	578.39	413.70	490.66	375.21	336.73	394.45	394.45	634.98	394.45	4656.49
Construction	10.69	7.46	11.32	8.85	14.73	7.59	8.73	7.46	10.75	10.88	6.13	104.59
Wholesale & retail trade/ repair vehicles	26.62	11.64	24.50	19.36	23.74	18.30	17.54	17.39	17.54	24.95	16.18	217.77
Transport and storage	31.05	16.10	26.45	19.55	39.95	40.25	105.80	24.15	24.15	19.55	27.60	372.61
Accom. and food services	4.74	2.46	3.98	3.05	4.66	2.96	2.88	3.39	2.46	4.40	3.30	38.27
Information and comms.	5.27	2.29	4.32	2.56	3.60	2.41	2.96	2.64	2.16	4.21	3.70	36.12
Financial and insurance activities	.29	0.12	0.24	0.22	0.29	0.12	0.10	0.14	0.16	0.95	0.14	2.77
Real estate activities	2.47	.73	1.95	1.29	1.48	1.09	0.82	0.92	1.25	2.47	0.96	15.43
Professional, scientific and technical activi-ties	7.10	2.41	5.15	3.53	4.42	2.20	2.06	2.88	2.84	5.49	3.45	41.52
Admin & sup-port services	6.20	2.42	4.42	3.39	4.88	2.78	2.68	2.94	3.29	4.72	3.10	40.83
Education	1.24	.47	1.28	0.81	1.07	0.64	0.51	0.73	0.73	1.41	0.73	9.63
Human health & social	4.95	2.43	4.28	2.93	4.53	2.26	1.93	2.85	2.85	3.60	3.02	35.54
Arts, entertain-ment & recrea-tion	3.32	1.21	2.52	1.86	2.21	1.46	1.33	1.69	1.69	2.79	1.64	21.67
	606.74	234.05	679.76	525.11	616.99	467.90	488.63	508.38	508.33	778.07	473.51	5854.26

(Source ONS and BEIS, multiple data sources 2019)

APPENDIX 4: ADDITIONAL DATA

Table 9: Surrey business park analysis (actual data in black, estimated data in red)

Name of business park	District	Building data	Estimated Total $KgCO_2$/ annum	Estimated Total $ktCO_2$/ annum
Bourne Business Park (near Heathrow)	Runnymede	Building 200	15902.99	0.016
		Building 400	56666.24	0.057
		Building 300	186483.53	0.186
		Building 100	17735.00	0.018
		Building 500	17735.00	0.018
		Building 600	177350.00	0.177
Tanshire Business Park	Waverley		64253.91	0.064
Weybridge Business Park	Runnymede	Building 1 - Toshiba	124823.19	0.125
		Building 2 CHEP	-	-
		Building 3 - Malyan Building	-	-
		Building 4	29583.22	0.030
		Building 5	47667.78	0.048
		Building 6	59845.34	0.060
Brooklands Business Park	Elmbridge	Avro Way Buildings	-	-
		The Heights Brooklands	18110.80	0.018
		Regus - Weybridge Brook-lands Business Park	-	-
Frimley 4	Surrey Heath		-	-
Perrywood	Reigate and Banstead		-	-
Lansbury Business Estate	Woking		-	-
Farnborough BP	Guildford		-	-
Abbey Mils	Guildford	The Mill	23509.20	0.024
		The Granary	46074.24	0.046
		The Wharf	33690.63	0.034
Copthorne BP			-	-
Guildford BP		Colgate Palmolive		0.477
Surrey Research Park	Guildford	31 Buildings	3106620.72	3.107
		inc Surrey Technology Centre	529043.51	0.529
Goldsworth Park Trading Est.	Woking			
Waterside Trading Estate	Elmbridge			
Total				**5.032**
Local Authority emissions 2018 (kt CO_2) Industry and Commerce				1288
% of Industry and Commerce emissions				0.39%

Source: EPC and website information, various dates

NOTE: greater detail available for Surrey Research Park

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