CONSUMPTION-BASED GREENHOUSE GAS EMISSIONS FOR LONDON AND ITS BOROUGHS

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1 Introduction

London boroughs are taking ambitious action on climate change, with accelerated targets for reaching net zero; they have also made climate change one of their key shared ambitions in their collective work through London Councils[1]. The Mayor of London has set a target for London to be net zero carbon by 2030. A suite of major programmes underpins London Government's collaboration, including the One World Living programme, which focuses on reducing consumption-based emissions with a target of a two-thirds reduction by 2030.

Since 2018, the Greater London Authority (GLA) has commissioned University of Leeds to produce a regional consumption-based greenhouse gas (GHG) emissions account for the Greater London area. In 2021, the University of Leeds was commissioned by London Councils and ReLondon to provide consumption-based GHG household emissions profiles for the 32 London Boroughs and the City of London, for the years 2001-2018. The borough-level profiles have created a far more granular understanding of emissions in London, and effective strategies to reduce them. In 2023, the study was re-commissioned, with the focus expanded to report emissions both at the GLA level and at the borough level. This report documents the consumption-based accounts (CBA) for GHG emissions for Greater London, the boroughs and the City of London for the period 2001-2020.

The CBA considers the emissions that occur due to the consumption of London residents, including all the emissions associated with the production of goods and services throughout their complete supply chain. A population weighted share of the UK consumption-based emissions associated with Government consumption and capital investment is also included in the CBA.

University of Leeds is responsible for producing the CBA for the UK Government (Owen & Barrett, 2019). These results are now badged as an Official Statistic[2]. The same over-arching methodology has been applied to calculate the CBA for Greater London, the London boroughs and the City of London. This means that the sum of the footprints for the 32 London boroughs and the City of London will equal the emissions associated with consumption reported by the GLA. The predominant methodology is an "Environmentally Extended – Multi Regional Input Output" model (EE-MRIO). This has become the standard approach to assess the consumption-based emissions of a country or region. EE-MRIO is the most comprehensive, versatile and compatible approach for consumption-based accounting of GHG emissions and has become the norm (Davis & Caldeira, 2010; Hertwich & Peters, 2008; Peters et al., 2011).

In this report, section 2 provides definitions of the three ways GHG emissions can be allocated to a region: territorial-based, production-based and consumption-based and gives information on what is included and excluded in the account. Section 3 is an overview of the methods and datasets used for this project. The results are presented in section 4, starting with the results for Greater London, then the high-level results for the boroughs. The report concludes with recommendations and next steps. An appendix includes a deep-dive into the results for a single borough with guidance as to how to interpret the findings, technical notes on methodology and details of classification systems used.

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[1] https://www.londoncouncils.gov.uk/node/39789
[2] https://www.gov.uk/government/statistics/uks-carbon-footprint

2 Definitions and clarifications

2.1 Emissions accounting definitions

GHG emissions can be allocated to a country or region in different ways: (1) territorial-based, (2) production-based, and (3) consumption-based emission reporting.

2.1.1 Territorial Emissions

The United Nations Framework Convention on Climate Change (UNFCCC) requires countries (Annex I and/or national governments that are Parties to the UNFCCC and/or the Kyoto Protocol) to submit annual National Emission Inventories. These inventories are used to assess the progress made by individual countries in reducing GHG emissions. The UNFCCC follows the Intergovernmental Panel on Climate Change's (IPCC) Guidelines for National GHG Inventories which is, "emissions and removals taking place within national (including administered) territories and offshore areas over which the country has jurisdiction" (IPCC, 2007). According to this definition, GHG emissions emitted in international territory, international aviation and shipping, are only reported as a memo and not allocated to individual countries. In the UK, the Department for Energy Security and Net Zero (DESNZ) reports these emissions as the UK's GHG Inventory and they form the basis for reporting on progress towards our domestic and international emissions reduction targets. In this report, this type of accounting is called "**territorial-based emission inventories**".

At the local level, DESNZ reports 'UK local authority and regional greenhouse gas national statistics' from 2005 to 2020[3]. These data are described as "territorial emissions" and DESNZ explains that "the data show emissions allocated on an "end-user" basis where emissions related to energy use are distributed according to the point of energy consumption. Emissions that are not energy related are distributed based on the point of emission, other than emissions from waste management which are distributed based on where the waste was produced."

2.1.2 Production Emissions

In official reporting to Eurostat[4], GHG emissions are allocated in a consistent manner to the system boundary for economic activities such as the Gross Domestic Product (GDP) used in the System of National Accounts (SNA). This boundary reporting is known as the residence principle. In the SNA, international aviation and shipping are typically allocated to countries based on the operator of the vessel. Particularly in Europe (Eurostat), these inventories are often known as "National Accounting Matrices including Environmental Accounts (NAMEAs)". In the UK, the Office for National Statistics (ONS) publishes this account as part of the UK Environmental Accounts. The figures represent emissions caused by UK residents and industry whether in the UK or abroad and includes emissions from aviation and shipping, but excludes emissions within the UK which can be attributed to overseas residents and businesses and those emissions from Land use, Land Use Change and Forestry. In this report, these emissions are called "**production-based emission inventories**".

This project is not aware of any datasets of production emissions or NAMEAS at the UK local authority level.

2.1.3 Consumption Emissions

Consumption-based emissions allocate emissions to the consumers in each country, based on final consumption as in the SNA. Conceptually, consumption-based inventories can be thought of as

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[3] https://www.gov.uk/government/collections/uk-local-authority-and-regional-greenhouse-gas-emissions-national-statistics

[4] The statistical office of the European Union

consumption equals production minus exports plus imports (see Figure 1). Consumption-based emissions do not have to be reported officially by any country, but they are increasingly estimated by researchers (see review by Wiedmann 2009). In the UK, the Department for Environment, Food and Rural Affairs (Defra) publishes the consumption-based emissions calculated by the University of Leeds as an Official Statistic. Consumption emissions are calculated by re-assigning Global production emissions to the point of consumption using a multi-regional input-output database (MRIO). In this report, these are called "**consumption-based emission inventories**" or "the Carbon Footprint".

2.1.4 Comparison of territorial, production and consumption accounts at the UK level

Table 1 provides a simplified view of what is included and excluded in emissions accounts for the UK.

Table 1: Types of emissions inventory included in UK territorial, production and consumption accounts. Green indicates inclusion and red indicates exclusion. RoW = rest of world

Emissions from…	UK Territorial	UK Production	UK Consumption
industries owned by UK, located in UK making products consumed by UK	(green)	(green)	(green)
industries owned by UK, located in UK making products consumed by RoW	(green)	(green)	(red)
industries owned by RoW, located in UK making products consumed by UK	(green)	(red)	(green)
industries owned by RoW, located in UK making products consumed by RoW	(green)	(red)	(red)
industries owned by UK, located in RoW making products consumed by UK	(red)	(green)	(green)
industries owned by UK, located in RoW making products consumed by RoW	(red)	(green)	(red)
industries owned by RoW, located in RoW making products consumed by UK	(red)	(red)	(green)
industries owned by RoW, located in RoW making products consumed by RoW	(red)	(red)	(red)
bunker[5] aviation & shipping owned by UK and used by UK residents	(red)	(green)	(green)
bunker aviation & shipping owned by RoW and used by UK residents	(red)	(red)	(green)
bunker aviation & shipping owned by UK and used by RoW residents	(red)	(green)	(red)
bunker aviation & shipping owned by RoW and used by RoW residents	(red)	(red)	(red)
UK citizens' activities within UK territory	(green)	(green)	(green)
RoW citizens' activities within UK territory	(green)	(red)	(red)
UK citizens' activities within RoW territory	(red)	(green)	(green)
RoW citizens' activities within RoW territory	(red)	(red)	(red)
land use, land use change and forestry	(green)	(red)	(red)

Figure 1 demonstrates the relative sizes of the UK territorial, production and consumption emissions accounts. In this example we use data for 2020. The additional flows that are included in the

[5] Emissions from fuel used for international aviation and shipping are not subject to the limitation and reduction commitments of Annex I Parties under the Convention and the Kyoto Protocol – they are not included in the Territorial totals reported by countries (see https://unfccc.int/topics/mitigation/workstreams/emissions-from-international-transport-bunker-fuels)

production account (the Environmental Accounts) include: bunker fuels from aviation and shipping; emissions from renewables and waste derived fuels (biomass); the net emissions from the inclusion of overseas emissions from UK residents and the removal of domestic emissions from non-residents; and the removal of emissions from crown dependencies, overseas territories (the Channel Islands and Gibraltar) and Land Use Change, Land Use and Forestry (LULUCF). The figure also reveals the portion of UK consumption emissions originating abroad (emissions embodied in imports) and UK production emissions which are exported. It is clear that there is a marked difference in end results depending on the chosen emissions accounting system (Barrett et al. 2013). Due to issues of national sovereignty, binding agreements on emissions may focus primarily on territorial-based emission estimates meaning that no targets are set for emissions associated with bunker fuels and imported products.

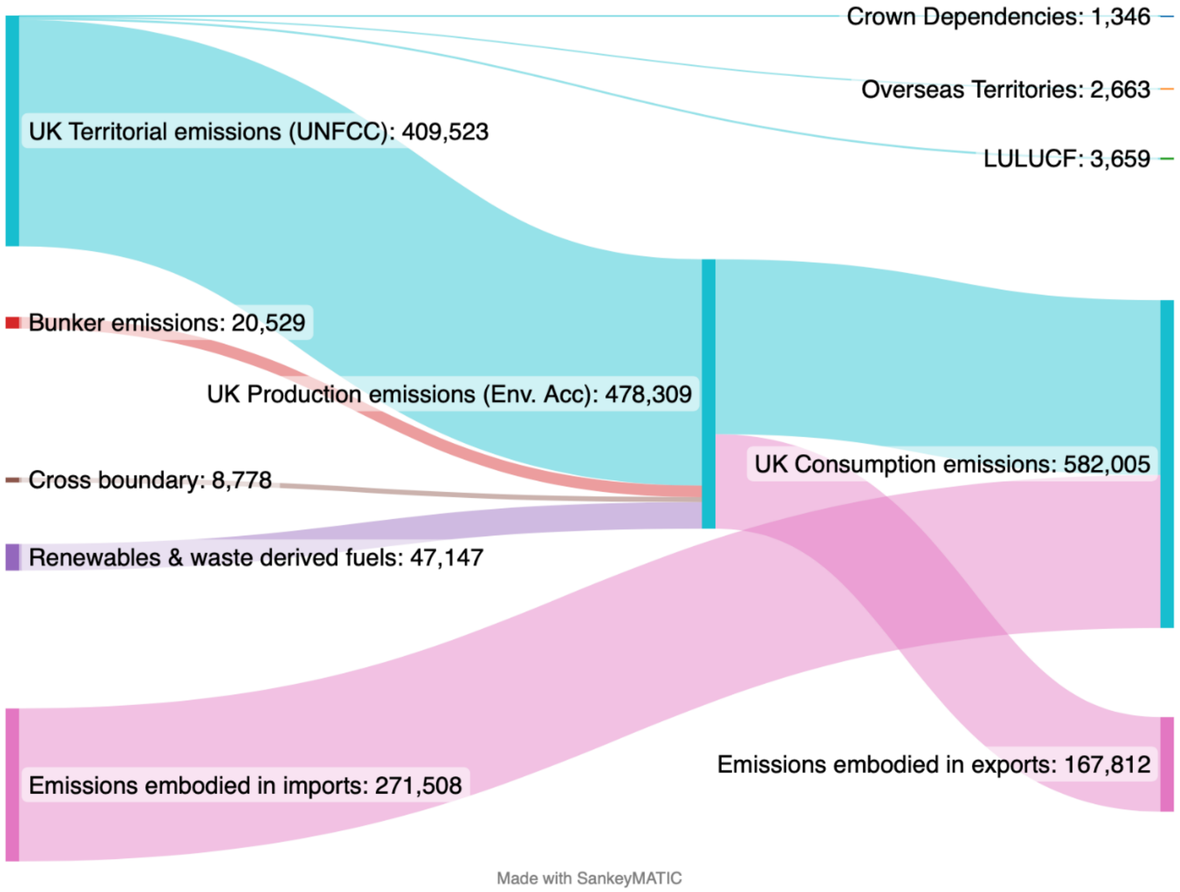

Figure 1: UK emissions from territorial, production and consumption in 2020. Measured in KtCO₂e *(https://www.ons.gov.uk/economy/environmentalaccounts/datasets/ukenvironmentalaccountsatmosphericemissionsbridgingtables)*

2.2 Consumption emissions accounts at the local level

2.2.1 Methods for calculating subnational consumption emissions accounts

One way of calculating the emissions at the subnational level would be to use a **subnational MRIO database** which contains information on UK local authorities (LA) rather than the whole of the UK. This database would need information on the production emissions by LA industry (the production account) and detailed economic data on how industries within the LA buy and sell with other industries in the rest of the UK and the rest of the world. At present, neither the production emissions data nor the economic transactions data exist in a detailed enough format to calculate consumption-based emissions for UK local authorities in this way.

This project instead, takes a **hierarchical approach** to accounting for emissions at the subnational level. Emissions, by consumption item, at the national level are shared out to regions, then local authorities, based on the proportion of the UK spend on the item each smaller geography has. This means that if you sum the emissions on food consumption by all Local Authorities in London it will be equal to total food footprint of London and similarly the footprints of the devolved regions sum to the official UK figure.

2.2.2 Disadvantages of the hierarchical method

It is important to recognise that the hierarchical footprint is entirely constructed by shares of UK spend. This means that the following are assumed:

- Costs of items are broadly similar country wide. The emissions associated with spending £1 on bread in Harrow are the same as spending £1 in bread in Harrogate.
- Items are produced in the same way, regardless of where in the country they are bought. It is assumed that the industries involved in making bread bought in Harrow are the same as those involved in making bread bought in Harrogate. This distinction also includes the contribution of foreign industries in an item's supply chain. Essentially, the carbon multiplier for bread is the same country wide.
- Imports make up the same share by product item country wide. It is assumed a certain percentage of the bread bought in Harrow is imported. This is the same share as the UK and the same share that would be used in Harrogate.
- At the national level it is possible to look at the portion of production-based emissions that are consumed by the UK (production emissions minus exports) and to calculate what portion of the consumption account is imported. At the local level, imported emissions would mean emissions that occur outside of the local authority's or region's boundary and could be sourced in a neighbouring authority, somewhere else in the UK or abroad. Unfortunately, these types of calculations require the subnational MRIO database. It is not possible to provide LAs and regions with a calculation of the proportion of emissions that are sourced outside of their boundaries, from other parts of the UK and abroad.

2.2.3 Advantages of the hierarchical method

- Emissions are consistent with the UK consumption-based account and the sum of the local areas will equal the national total.
- Policies and recommendations constructed at the national level can be considered at the local level.
- At present this is the only way to calculate this type of account

2.2.4 What is a local level consumption-based account?

The consumption-based approach assigns emissions associated by final consumption in the UK to the geography where the **final consumers** of the product live.

It is important to understand that the **emissions profiles are not a measure of the emissions associated with businesses in the borough or vehicle traffic flows** – these are covered by territorial GHG inventories such as the London Energy and Greenhouse Gas Inventory (LEGGI). The emissions profiles in this project are solely emissions associated with consumption of goods and services by residents; those direct emissions from residents' fuel burning from private cars and homes; and a population weighted share of Government and Capital Investment. There is some cross over with the territorial inventory (Figure 2). Emissions from local businesses are reflected in the consumption total if the goods sold are purchased by London residents. Traffic emissions are included in the consumption account if the driver is a local resident or the emissions are from the transportation of goods or services that are consumed by local residents.

Emissions inventories from businesses and traffic flow in London are not used in the construction of the consumption-based account – the calculation is solely based on shares of spend of the national total.

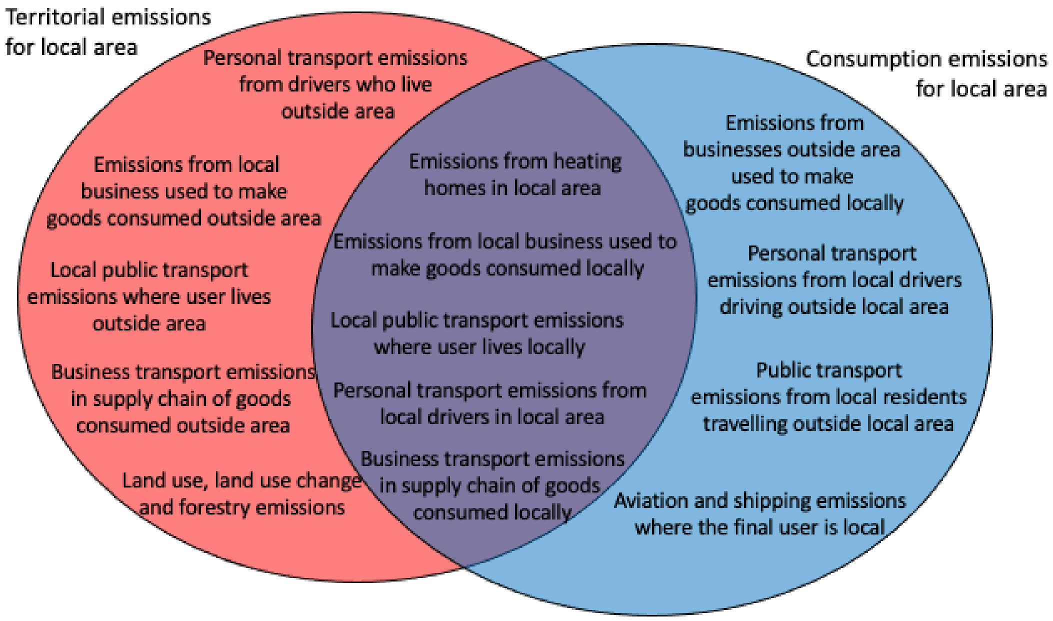

Figure 2: Venn diagram showing relationship between local territorial and consumption-based accounts

2.2.5 Domestic consumption

At the national level, calculations can be made about domestic consumption. For example, it is possible to calculate the proportion of the UK's carbon footprint that is domestic. Or it is possible to calculate what proportion of the UK's domestic emissions are consumed domestically (and what is exported).

Because this project uses shares of final consumption to allocate emissions subnationally, it is only possible to calculate the portion of the emissions that are sourced in the UK. It is not possible to calculate the portion of London's consumption account that is sourced from London. Similarly, it is not possible to calculate the portion of domestic emissions consumed by London businesses or the portion of London emissions consumed by London businesses. For example, in Figure 2, it is not possible to determine the size of the intersection area shown in purple but it is possible to calculate the size of the blue and purple sections together.

2.2.6 A subnational MRIO database?

To answer questions such as:

- What portion of London's consumption account is sourced from London?
- What portion of domestic emissions are consumed by London businesses?
- What portion of London emissions are consumed by London businesses?

a subnational MRIO database is required. This database, instead of having a single UK region, would understand trade between smaller geographies in the UK and how these places traded with the rest of the world.

This data is not available for the UK at the level of product resolution needed for accurate consumption-based accounting. It would also produce results that are inconsistent with the national UK level figure – i.e. the sum of the lower level geographies would not sum to the official total because they would have been calculated using different model types.

2.3 Accounting terminology

2.3.1 Non-household expenditure

The UK carbon footprint assigns emissions to final consumption by Households, Government and Gross Fixed Capital Formation.

Household expenditure is defined by the ONS as "as personal expenditure on goods and services, including imputed rent of owner-occupied dwellings, the administrative costs of non-life insurance and life insurance, and superannuation schemes". This means that day-to-day household costs are included and rents are included and an estimate of what you'd pay in rent if you are an owner occupier is included. The ONS goes on to explain that "Business expenditure and expenses, interest and other transfer payments and capital expenditure on dwellings are all excluded from household final consumption."[6] This means that the cost of actually buying a house and major house works are excluded because they are part of Gross Fixed Capital Formation.

Government expenditure is public spending on Public Administration (including Defence) and Health services. In this work, Government includes both UK Central Government and Local Government.

Gross Fixed Capital Formation relates principally to industry investment in tangible fixed assets such as plant and machinery, transport equipment, dwellings and other buildings and structures. However, it also includes investment in intangible fixed assets, improvements to land and also the costs associated with the transfer of assets. The investment relates to assets which are used repeatedly in the production process for more than one year and as such covers such purchases as: software, mineral exploration and purchases of dairy cattle. This means that households' spend on products don't include the emissions associated with industry's spend on large capital goods. Capital becomes its own separate account.

It was possible to generate carbon footprints of households based on the unique household spend profile at the Local Authority and regional level. The equivalent spend profiles for Government and Gross Fixed Capital Formation are not available, so the UK emissions associated with these final demands are shared on a population weighted basis. It was decided that this methodology for distributing the emissions is a reasonable assumption because much of the impact associated with UK Government spend is for shared services such as the NHS, defence and education which it is assumed are used in proportion to the number of people residing in a region.

2.4 Composition of the GHGs

The 2023 release of the UK, Greater London Authority, the London Boroughs and the City of London consumption-based accounts includes the full suite of GHGs using Global Warming Potentials from AR5, as reported to the UNFCCC. These are:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)

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[6] https://www.ons.gov.uk/economy/nationalaccounts/satelliteaccounts/methodologies/consumertrendsuk

- Hydro-fluorocarbons (HFC)
- Perfluorocarbons (PFC)
- Nitrogen trifluoride (NF3)
- Sulphur hexafluoride (SF6) all measured in kilotonnes CO2e

3 Methodology and data sources

3.1 Overview of the EE-MRIO methodology

Input-output models (IOM) have been adopted by environmental economists due to their ability to make the link between the environmental impacts associated with production techniques and the consumers of products. An environmentally-extended multiregional input-output model (EE-MRIO) uses matrix algebra to transform production-based emissions from industries anywhere in the world to the point of consumption. This means it is possible to calculate the consumption-based emissions of nations which take into account the GHGs from full supply chain of production, regardless of where in the world production stages took place. Once the nation's CBA is calculated, the emissions associated with smaller geographies can be determined.

For further detail on the mathematics used in input-output analysis, see the Appendix.

3.2 Data sources

This project will use the University of Leeds' UKMRIO model (Owen & Barrett, 2020; Owen et al., 2018). The set of emissions multipliers produced by the UKMRIO model can be found on the UK Government statistics webpage[7]. For this project the data on final demand for Greater London and each of the London boroughs and the City of London will need to be constructed because the UKMRIO only contains the information on total UK demand for goods and services. This project needs to calculate what proportion of the total UK spend the Greater London Area is responsible for and then, what proportion of Greater London spend each of the individual London administrative areas is responsible for, for each consumption item contained in the database. For example, if households in Harrow spend 30 per cent of the total London household spend on clothing, it will receive 30 per cent of the total London household footprint associated with clothing. To understand the portion of London households' spend by product attributed to each administrative area this project uses two approaches:

Firstly, for domestic consumption of gas and electricity the 'Regional and local authority consumption statistics' produced by DESNZ are used, which give estimates of gas and electricity consumption at the region and Local Authority level for Great Britain for the years 2005-2020. The data is converted into proportions (i.e., what proportion of the total gas and electricity use for London is each administrative area using) and trend projections are used to project the data back to 2001. Home energy use represents around a quarter of a household's consumption-based emissions account and so using data on real energy use is an advantage and will lead to a more accurate estimate of household consumption-based emissions.

[7] https://www.gov.uk/government/statistics/uks-carbon-footprint

Secondly, for all other consumption, the project constructs unique spend profiles using the Living Costs and Food Survey (LCFS) and the census output area classification (OAC) for Greater London and each of the 32 London boroughs and the City of London.

3.3 Using the LCFS and the OAC to construct borough spend profiles

Since 1957, the Office for National Statistics (ONS) has annually surveyed UK households on their weekly expenditure (UK Data Service, 2019). In 2008 this survey became known as the Living Costs and Food Survey (LCFS). The LCFS achieves a sample of around 6,000 UK households annually and is used to provide information on GDP, retail price indices, National Account estimates of household expenditure, the effect of taxes and benefits, and trends in nutrition. In addition to providing information on household spend on over 300 different product types (coded by the European Standard Classification of Individual Consumption by Purpose (COICOP))[8], further information is collected such as the age, sex and occupation of members of the household, the total household income, the Government Office Region they reside in and the household classification of the census output (OAC). The characteristics of each sampled household are compared to the characteristics of all UK households using the UK census. The survey strives to produce a representative sample of the 27 million UK households. For each of the 5000+ household surveys in the 2020 release, a weight is supplied to indicate the proportion of UK households that are represented by this profile. For example, the first household in the 2020 survey has a weight of 2,990 and the sum of every weight is 28,198,240. In all calculations for this study, we use the weights to convert the sample into a set of data that is representative of all 28 million households in the UK.

The LCFS is available in a format that is comparable for the years 2001-2020. This means that results for the devolved regions and administrative districts below this level start from 2001.

Since the LCFS collects information on the household's Government Office Region, it is possible to construct a spend profile for households in Greater London. The proportion of spend by product that Greater London spends compared to the UK total is calculated. Multiplying these proportions by total UK footprint by product disaggregates the household consumption-based GHG emissions for the UK down to Greater London level. The population share of government and capital investment impact is then added. This method ensures that the sum of the regions equals the total footprint. Locational information on the borough where the surveyed households live is not available, so it is not possible to follow this method to calculate borough level CBAs.

3.3.1 The OAC hierarchy

To construct spend profiles for the London boroughs and the City of London, the output area classification (OAC) data recorded in the LCFS is used. The OAC is the ONS's free and open geodemographic household segmentation. The OAC provides "summary indications of the social, economic, demographic, and built characteristics" of the census Output Areas (OA) of the UK (Gale et al., 2016, p1). The OAC is constructed using datasets from the UK Census and there have been two versions of the classification: one that classifies the 2001 output areas using data from the 2001 census (Vickers & Rees, 2007) and one which classifies the 2011 output areas using data from the 2011 census (Gale et al., 2016). There will be a new OAC for the 2021 census but this data will not be

[8] https://unstats.un.org/unsd/classifications/unsdclassifications/COICOP_2018_-_pre-edited_white_cover_version_-_2018-12-26.pdf

available until 2024 at the earliest, after the 2021 census has been published at its most detailed level.

Geodemographic classifications use mathematical clustering algorithms to generate groupings such that the differences *within* any group are less than the difference *between* groups. Once a set of groups is generated, the creators of the classification system name the individual groups based on features of the profile and write short "pen portrait[9]" descriptions of them (Gale et al., 2016). Vickers & Rees (2007, p399) describe the naming process as "difficult and perilous" and note that some names appear to be contentious, particularly when describing what could be perceived as negative characteristics. However, Gale et al. (2016, p15) point out that the process "help[s] end users to identify with the names and description given to local areas" and that the "descriptors had strong and literal links to the underlying distributions revealed by the data". The 2001 and 2011 OAC classification names can be found in the appendix.

Both OACs follow a three-tier classification of supergroups, groups and subgroups (see Table 2). For example, the 2011 supergroup type 5 is 'Urbanites', the group type 5a is 'Urban professionals and families' and the subgroup type 5a3 is 'Families in terraces and flats'.

Table 2: Properties of the 2001 and 2011 OAC

	2001 OAC	2011 OAC
Number of supergroups	7	8
Number of groups	21	26
Number of subgroups	52	76

The LCFS records the 2001 OAC type in the survey years 2008-2013 and the 2011 OAC type in the survey years 2014-2020. No OAC type is recorded in the LCFS for the years 2001-2007. Using the LCFS, average spend profiles are generated for each classification type (for the supergroups, groups and subgroups) by summing the surveys that are characterised by each OAC type and dividing the product spends by the total weights assigned to these surveys – essentially producing an average spend by product by household OAC type. This is done for each year to reflect the fact that an OAC type will change its spend pattern over time. For the years 2001-2007, the spend profiles for 2008 are used as a proxy. If the number of households of each type recorded in each borough is known, it is possible to produce a total spend profile for the borough. The proportion that the borough spends compared to the total for London is then calculated. This method ensures that the sum of the boroughs plus the City of London equals the total footprint of Greater London.

To ensure that the spends captured for the London boroughs truly reflect the character of spends of London households, rather than use the complete LCFS to generate spend profiles by OAC type, first only those surveys found in London are isolated. This means that instead of profiling the spend of, for example, a '3c2 Constrained Commuter' the profile of a 'London 3c2 Constrained Commuter' is generated. By restricting the surveys to the London surveys, there is a risk of having too few surveys for a representative sample of households classified as '3c2' (for example). The number of surveys in the LCFS from London households ranges from 678 in 2001 to 407 in 2014.

[9] https://www.ons.gov.uk/file?uri=/methodology/geography/geographicalproducts/areaclassifications/2011areaclassifications/penportraitsandradialplots/penportraits.pdf

To solve the issue of having too few surveys for a representative sample of certain OAC types, a hierarchical decision tree is used to generate the spend profiles by OAC type following a method developed by Kilian et al (2022). If the subgroup 'London 3c2 Constrained Commuter' is taken as an example OAC type, if there are 20 or more household surveys of this type, the average spend for 'London 3c2' is recorded. If there are fewer than 20 observations, move up the classification tree to the group 'London 3c Ethnic Dynamics'. If there are 20 or more observations for this type, any households with the classification type 3c2 will be given the expenditure profile of type 3c. Otherwise, move to the supergroup 'London 3 Ethnicity Central' and follow the same logic. Finally, if there are fewer than 20 observations at the supergroup level, the households classified as 3c2 would be given the London average spend profile (see Figure 3).

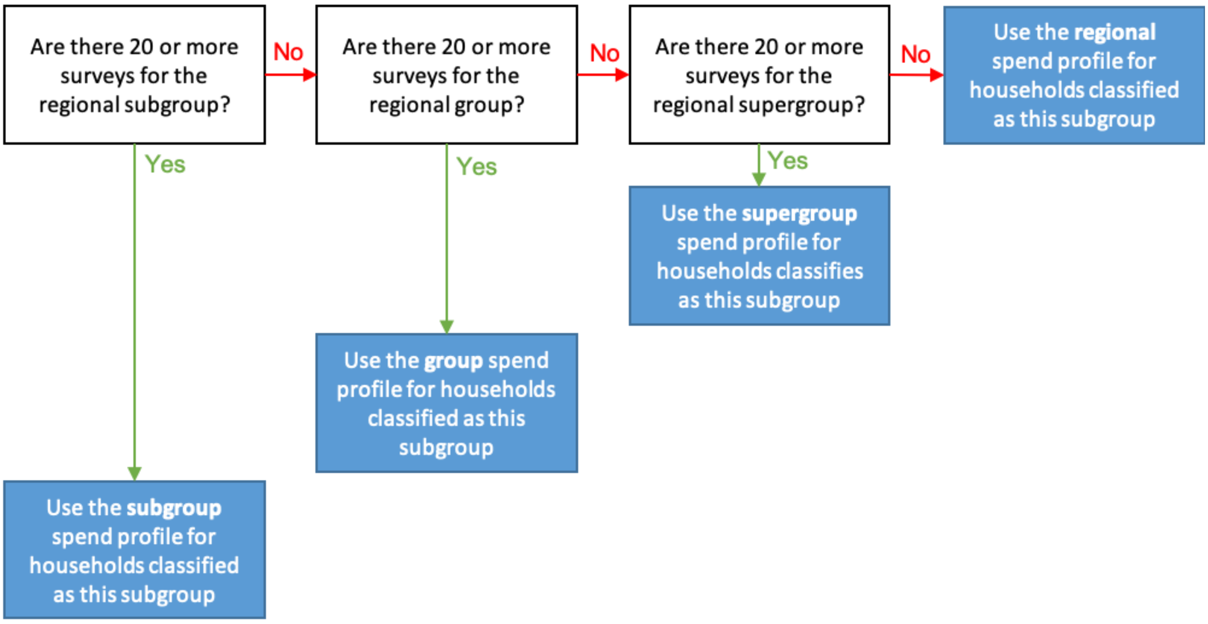

Figure 3: Hierarchical decision tree for assigning spend profiles

Table 3: Example of the 2011 OAC subgroups found in Harrow and the substitution OAC Group or Supergroup used if needed

Subgroup Code	OAC name	OAC code used	OAC name used
2a1	Student communal living	2	Cosmopolitans
2c1	Comfortable cosmopolitan	2	Cosmopolitans
2d1	Urban cultural mix	2d	Aspiring and affluent
2d3	EU white-collar workers	2d	Aspiring and affluent
3a1	Established renting families	3a1	Established renting families
3a2	Young families and students	3a2	Young families and students
3b1	Striving service workers	3b	Endeavouring ethnic mix
3b3	Multi-ethnic professional service workers	3b	Endeavouring ethnic mix
3c1	Constrained neighbourhoods	3	Ethnicity central
3d1	New EU tech workers	3d	Aspirational techies
4a3	Commuters with young families	4a3	Commuters with young families
4b1	Asian terraces and flat	4b1	Asian terraces and flat
4c1	Achieving minorities	4c	Asian traits
4c2	Multicultural new arrivals	4c2	Multicultural new arrivals
4c3	Inner city ethnic mix	4c3	Inner city ethnic mix

5a2	Multi-ethnic professionals with families	5a	Urban professionals and families
5a3	Families in terraces and flats	5a	Urban professionals and families
5b1	Delayed retirement	5	Urbanites
5b2	Communal retirement	5	Urbanites
6a1	Indian tech achievers	LONDON	London average
6b1	Multi-ethnic suburbia	LONDON	London average

Table 3 shows a record of the 2011 OAC subgroups found in Harrow and indicates whether the profile from the subgroup was used or whether it was replaced with a group, supergroup or regional average spend profile. In the 2020 LCFS there were 24 surveys from households living in London output areas classified as 3a2 Young families and students and this was deemed to be a sizable sample to create a spend profile for this subgroup. However, there were only 13 surveys from London households classified as 3b1 Striving service workers. For type 3b1, the group 'London 3b Endeavouring ethnic mix' was used as a proxy spend profile because once this level was reached in the OAC hierarchy, there were 35 surveys in the 2020 LCFS.

3.3.2 Disadvantages of using the OAC to estimate spend by local area

- This is not a measure of actual spend in each borough – it is an estimate of the predicted spend based on the profile of the people who live in the area
- If Harrow ran a successful sustainable food campaign[10], this would be picked up if the LCFS samples households living in Harrow. But we would see reductions in all parts of London where the OAC of the sampled household live. There is no way to match surveys to Local Authorities and have a large enough sample size to be sure it is representative
- The OAC is based on 2011 census and may be an out-of-date view of the area if it has undergone rapid change

3.3.3 Generating estimates of population by year, OAC and administrative region

Alongside estimates of the spend profiles by OAC types, the project needs to know how many households are of each type in each of the London Boroughs and the City of London for each year. 2001 was a Census year and each of the output areas (OA) in London was classified as one of the 52 different OAC types. It is possible to record the population and number of households by OA and link the 2001 OAs to higher level geographies such as the 2020 local authorities (which includes the 32 London boroughs and the City of London). Similarly, there is population and number of households data for 2011 from the 2011 Census. The issue is that an estimate of the population or number of households by OAC types, by borough, is needed for the years 2002-2010 and 2012-2020.

For the years 2002-2013, it was only possible to find population estimates at the local authority level. This growth rate in population can be applied to the number of households by OAC from 2001 to estimate the mix of household types by borough and the City of London. For these years it is assumed that household occupancy remains stable (the population per households) and it is assumed that if the population of a borough grew by 5%, the households classified by each OAC type grew at exactly the same rate. The mix of OAC types remains in the same proportion as observed in 2001. It is also assumed that the classification type assigned to an output area (OA) in 2001 is still relevant in 2013. It is assumed that the character of the individual OA has not changed.

[10] For example see https://eatlikealondoner.com

For the years 2014-2020, population estimates are available at the output area level. This means varying growth rates by OAC type can be observed since some OAs might grow faster than others within a borough. However, the assumption remains that the classification type assigned in the 2011 census is relevant in 2020. Again, it is assumed that the character of the individual OA has not changed and that household occupancies by OAC type are constant over the time period.

Now annual estimates of number of households by OAC by borough and annual estimates of spend by households by OAC type are available. Multiplying the two together gives a total spend by product by borough. Table 4 summarises the datasets and methods used to generate the spend profiles for the boroughs and the City of London. A traffic light system is used to indicate the reliability of the datasets and methods. It is then a simple step to work out the proportion of the total London spend by product that each borough is responsible for and apply these proportions to Greater London household consumption-based account (HCBA) to produce the HCBAs for the 32 boroughs and the City of London

Table 4: Summary of datasets and methods used to generate spend profiles for the boroughs and the City of London

	OAC classification type used	OAC spend data	Population by OAC type and borough
2001	2001 OAC	Take OAC spend proportions from 2008 but match to 2001 London spends	Take household figures by OAC from 2001 census and sum to borough level
2002-2007	2001 OAC	Take OAC spend proportions from 2008 but match to 2002-2007 London spends	Take household figures by OAC from 2001 census and sum to borough level. Then use ONS dataset[11] on population change by LA level to calculate annual growth rate in households from a 2001 baseline. Apply this same percentage change to each OAC type in each LA.
2008-2013	2001 OAC	Annual spend profiles available in the LCFS	Take household figures by OAC from 2001 census and sum to borough level. Then use ONS dataset on population change by LA level to calculate annual growth rate in households from a 2001 baseline. Apply this same percentage change to each OAC type in each LA.
2014-2020	2011 OAC	Annual spend profiles available in the LCFS	Take household figures by OAC from 2011 census at the OA level. Use ONS dataset[12] on population change by OA for 2014-2020 to estimate number of households by OAC in the LAs.

3.3.4 A note on geographic accuracies and spend ranges

We use the LCFS to build up a picture of spend at the Local Authority level. Since this calculation contains records of spend by Output Area, it might be possible to produce sub-local authority level footprints. However, this should be viewed with caution since the smaller the geographic unit, the

[11] MYEB3_summary_components_of_change_series_UK_(2019_geog19).csv. Greater London has their own estimates of population change by London borough which differ from the ONS figures but this project aims to use a national dataset to ensure consistency with other data from the ONS and to match the population data used from the ONS from 2014-2019

[12] mid-2014-2019-coa-unformatted-syoa-estimates-london.xlsx

less likely the spend profile is to reflect a typical household. The spend profiles generated at the borough level should be seen as an average of all the types of households living in the area. As you consider smaller geographies you will get a smaller range of house types recorded.

With a spend profile which represents the average of a range of household types, it is tempting to record max and min spend profiles and max and min consumption-based accounts. Again, this comes with a warning – most boroughs of London contain at least one output area of every OAC type, meaning a range of footprints would be identical for each borough at the household level.

4 Results

The results section starts with a focus on Greater London, and moves on to a comparison of previous years' estimates of the Greater London consumption-based account. A deep dive into the results for Harrow follows.

4.1 Greater London Consumption-based account

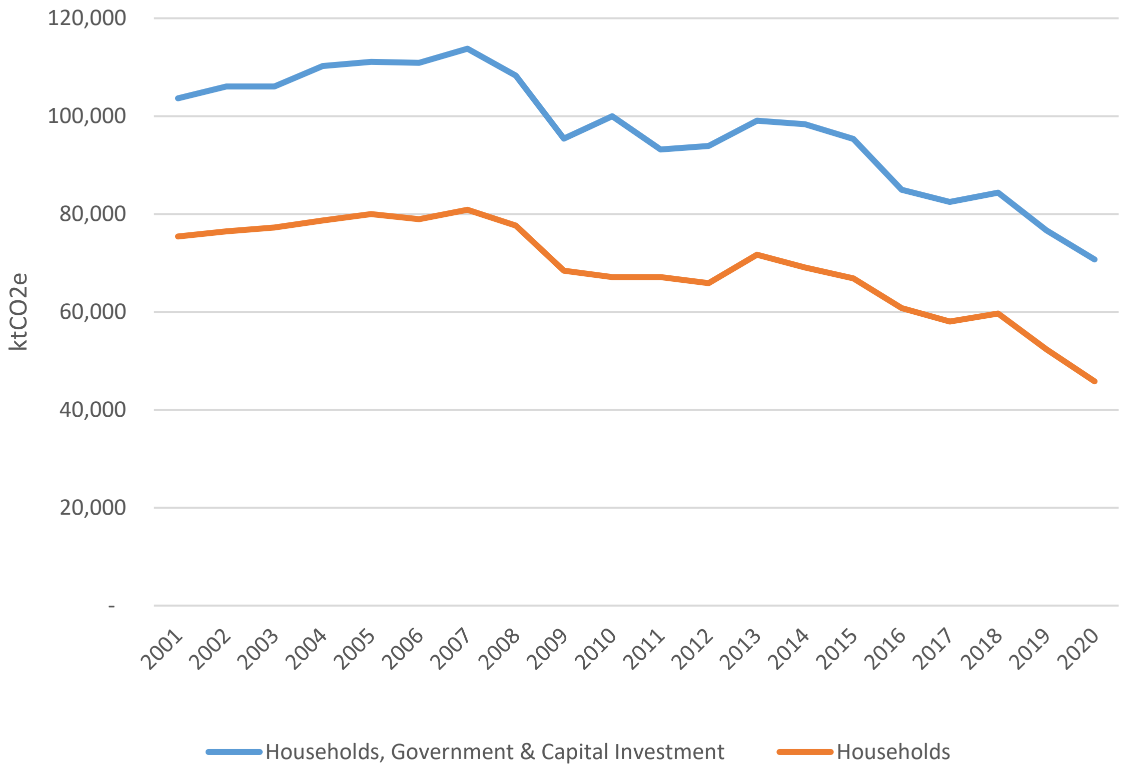

Figure 4: Total consumption-based GHG emissions for Greater London – all (Household, Government and capital investment) and households (2001-2020)

The total consumption-based emissions for Greater London have reduced from 104 Mtonnes CO2e in 2001 to 71 Mtonnes CO2e in 2020 (Figure 4). This is a reduction of 32%. Emissions specifically associated with household consumption have reduced from 75 Mtonnes CO2e to 45 Mtonnes CO2e – a reduction of 39%. The emissions for London slowly rose between 2001 and 2007 and reduced sharply during the recession years 2007-2009. During the recession, analysis of the UK results[13] shows that emissions reductions were caused by a reduction in spend and a preference to purchase

[13] https://www.carbonbrief.org/guest-post-why-uks-carbon-footprint-is-decreasing/

domestically produced goods rather than imports. 2009-2014, emissions stabilise with some fluctuation[14], then steadily reduced from 2014 to 2018. This period of emissions reduction is mainly driven by decarbonisation of the UK electricity sector. We see a further steep decline post 2018.

4.2 Emissions reductions post 2018: Ultra-Low Emissions Zone and COVID-19

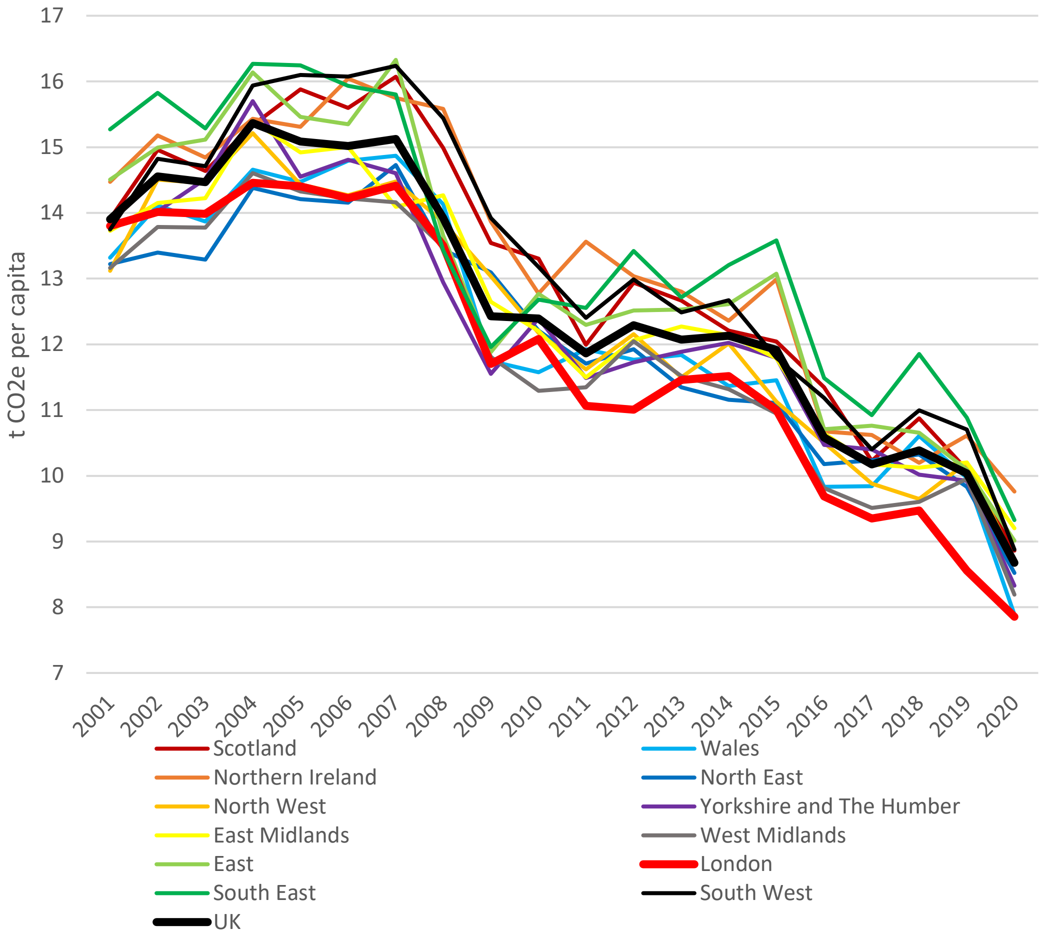

Figure 5: Per capita consumption-based GHG emissions for UK and all Government Office Regions (2001-2020)

Figure 5 shows per capita footprints for the UK (black), Greater London (red) and all other Government Office Regions from 2001 and 2020. All regions show a reduction between 2019 and 2020, with Wales reducing the most (by 20.9%) and Northern Ireland the least (8.0%) (see Table 5). Interestingly, Greater London reduces its per capita emissions in both 2018-19 (9.7%) and 2019-20 (8.2%). This clearly warrants further investigation – we would expect to see a greater emissions reduction effect during the COVID-19 pandemic in Greater London than in the previous year and it is unexpected to actually see a slightly greater sized reduction than in 2018-19.

Emissions reductions during the COVID-19 pandemic were greatest for consumption on car fuel, aviation and shipping. In Table 5 we see that most regions, Greater London included, reduced their car fuel emissions by 20-40% from 2019-2020 as car travel reduced during lockdowns and people worked from home. Londoners appeared to experience the same level of proportionate reduction between 2019 and 2020. However, emissions in Greater London associated with car fuel are at a

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[14] The slight uptick in 2012-2013 appears to be from higher than average spend on aviation in 2013 from London residents

much lower starting level due to a greater proportion of people travelling by public transport for their commute to work. Due to car fuel making up a lower proportion of an average Londoner's consumption-based emissions account, the effect on the total footprint of reducing car fuel purchases by around a third is lower. If we focus on the car fuel emissions change from 2018 to 2019, we also see large reductions in Greater London compared to elsewhere in the UK. We believe this to be the effect of the Ultra-Low Emissions Zone (ULEZ) which launched in April 2019[15]. Other studies have shown that in the first 10 months of the scheme launching, emissions of nitrogen oxides reduced by 35% and CO2 by 6%[16]. Our work observes the emissions associated with a reduction in spend on car fuel by Greater London residents in 2019.

Table 5: An investigation into the emissions reductions in total footprint and car fuel footprint for UK and Government Office Regions in 2018, 2019 and 2020

Region	Per capita % change in total		Car fuel emissions			Per capita % change in car fuel	
	2018-2019	2019-2020	2018	2019	2020	2018-2019	2019-2020
Scotland	-7.2%	-12.2%	1.43	1.37	1.10	-3.8%	-19.7%
Wales	-6.0%	-20.9%	1.62	1.52	0.88	-6.5%	-42.3%
Northern Ireland	4.1%	-8.0%	1.87	1.89	1.89	1.4%	-0.5%
North East	-4.8%	-13.3%	1.45	1.43	1.10	-1.5%	-23.2%
North West	5.8%	-14.7%	1.23	1.37	1.02	10.2%	-25.6%
Yorkshire & Humber	-0.9%	-16.1%	1.43	1.37	0.97	-4.1%	-28.8%
East Midlands	0.8%	-9.8%	1.64	1.51	1.31	-8.2%	-13.8%
West Midlands	3.7%	-17.7%	1.39	1.44	0.91	4.0%	-37.2%
East	-5.3%	-10.7%	1.51	1.58	1.21	4.2%	-23.2%
London	-9.7%	-8.2%	0.87	0.68	0.52	-27.2%	-23.7%
South East	-8.2%	-14.3%	1.52	1.45	1.12	-4.6%	-22.8%
South West	-2.7%	-17.0%	1.50	1.66	1.22	10.1%	-26.9%
UK	-3.3%	-13.6%	1.39	1.37	1.04	-1.2%	-24.7%

Greater London has seen annual per capita emissions reductions of almost 8-10% between 2018 and 2020 possibly because of ULEZ and the restrictions on travel in COVID-19. Due to Greater London's unique travel spending profile, the effect of COVID-19 on overall emissions was not a great as observed in other areas.

4.3 Comparing Greater London's results with previous years' releases

There have been several methodological improvements in the calculation of the emissions associated with Greater London. Some improvements are a legacy of changes made at the national level and since Greater London and the London borough CBAs derive from the national results, any changes seen at the national level filter through to the subnational results. Other changes are specific as to how the share of emissions is distributed by sub-national regions in the UK.

4.3.1 National level changes to the methodology and their effect

Figure 6 shows the evolution of the UK's carbon footprint over twelve years as calculated by University of Leeds and reported to Defra. The overall pattern is very similar throughout the model versions but there are substantial shifts in the size of the account which can be explained when

[15] https://www.london.gov.uk/press-releases/mayoral/ulez-launches-in-central-london
[16] https://www.london.gov.uk/new-report-reveals-transformational-impact-expanded-ultra-low-emission-zone-so-far

considering the methodological changes year on year. The newest UK release (of the data to 2020 shown in red) estimates a lower footprint compared to the previous year's release (of the data to 2019 shown in solid black) release but it is very similar to recent releases from previous years (shown in dashed lines). On average, this year's set of emissions are 13% lower than the last year's set but only 3% different to the version released three years ago (the 2020 release). The reasons for these differences are due to a major improvement in the way removals of taxes from imports are calculated and the changes to how the Global Warming Potential of non-CO2 GHGs are calculated in the IPCC's fifth Assessment Report (AR5).

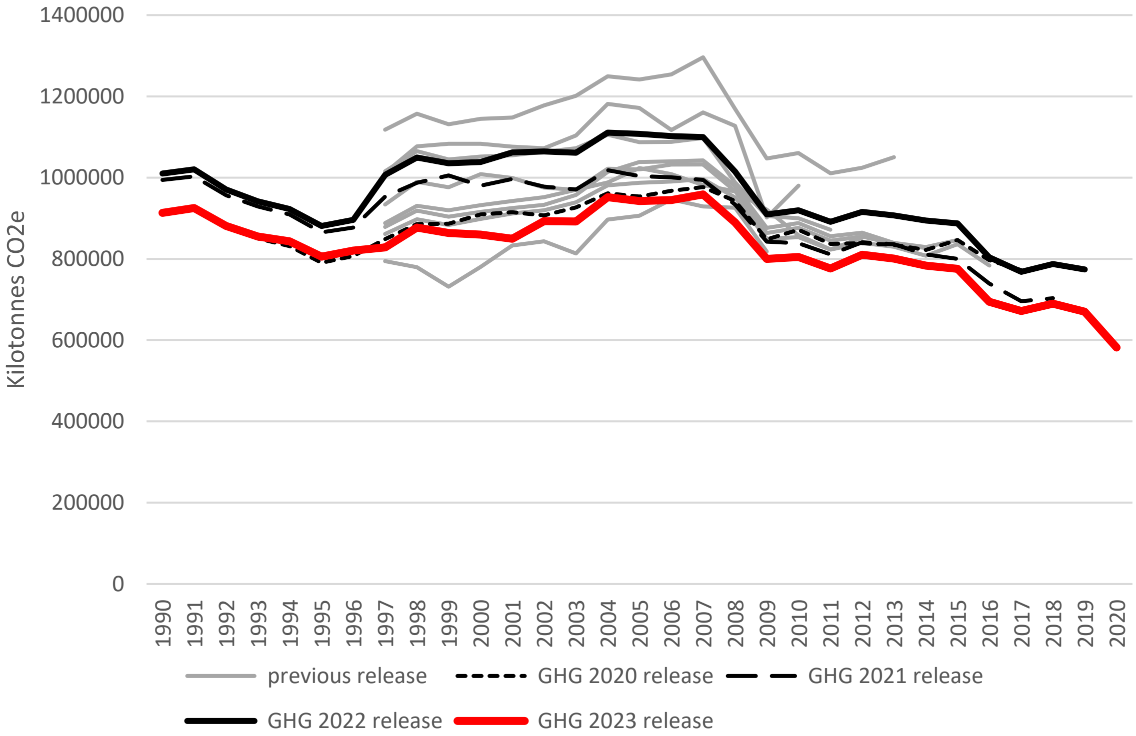

Figure 6: Evolution of the UK consumption-based account showing 11 years' of timeline estimates (1990-2019)

There was not a release of results for Greater London, the 32 London Councils and the City of London last year so the effect of this methodological change is not evident.

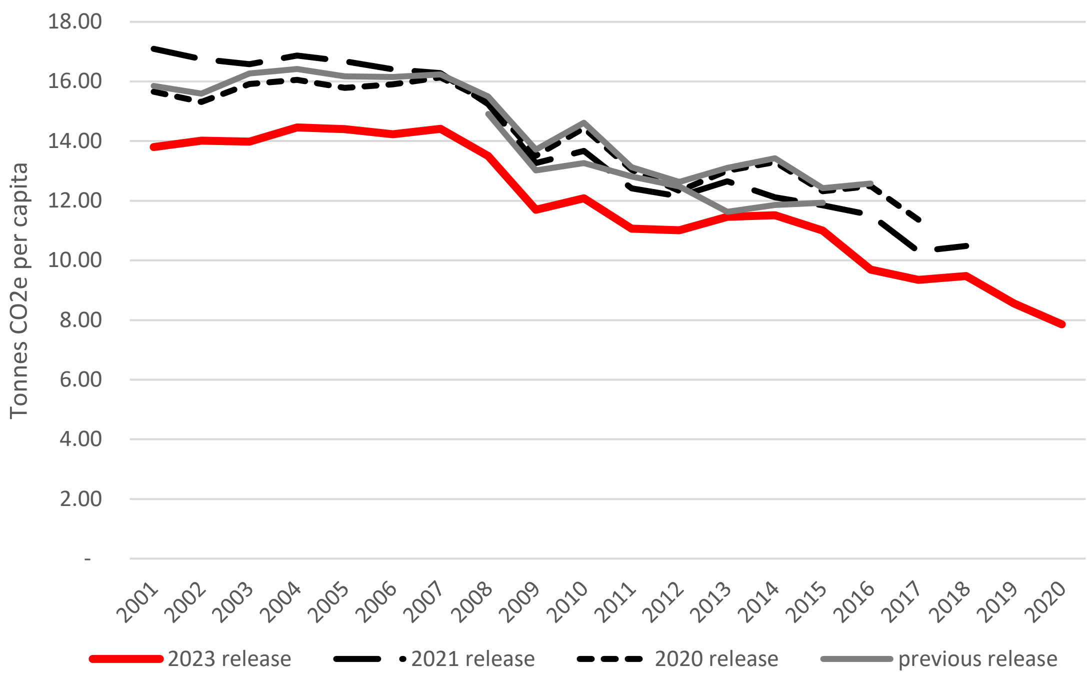

Figure 7: Evolution of the Greater London per capita Consumption-based account showing four years of timeline estimates (2001-2019)

Figure 7 above shows the evolution of the London results. The 2023 per capita release is on average 12% lower than the 2021 per capita release across the years 2001-2008. For the year 2018, in the most recent release, the footprint is estimated as 1.01 tonnes lower, compared to the release from two years ago. The nature of the national methodological changes has a particularly strong impact on London, due to the make-up of its CBA.

4.3.2 Changes in the regional share methodology

Two improvements have been made to the methodology which distributes the UK's emissions to the regional and local level. The first is an improvement to the method used to distribute emissions associated with direct fuel burnt in heating the home. In previous releases, all direct home heating emissions were shared at the regional level based on kWh of gas used. This does not include the direct emissions from burning liquid fuel and other solid fuel. This means that if a region, such as Northern Ireland, uses a lot of liquid and other solid fuel, they receive a disproportionately smaller share of the UK's direct emissions from home heating. To correct this, in the 2023 release, we first split the UK level direct home heating emissions by fuel type. Then just the gas portion can be split by gas kWh usage and other fuel types are distributed based on regional spends on these fuels. The effect of this methodological change is that for Northern Ireland, we see an increase in the share of the UK's direct home heating emissions and every other region sees their share reduce. This means that London sees a reduction due to a previous over estimation of emissions from gas use.

Figure 8 shows that the new methodology instigated in 2023 reduces the average per capita gas footprint in London by 18% (0.26 tonnes CO2e) and increases the Other fuel footprint in Northern Ireland substantially.

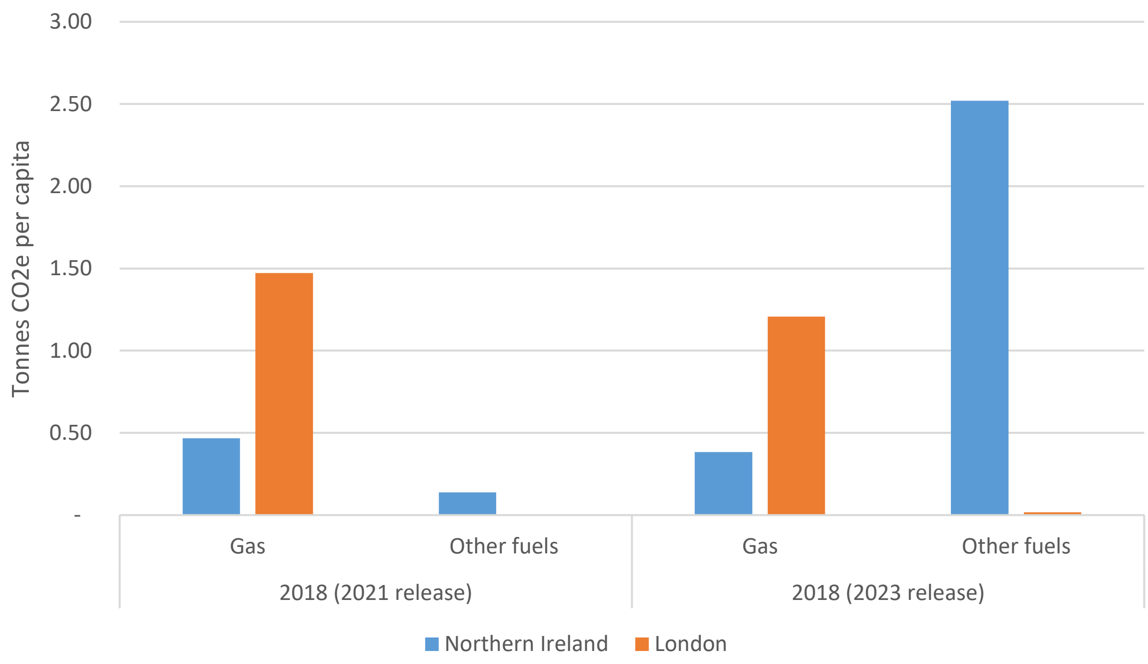

Figure 8: Comparison of 2018 fuel per capita footprints for Gas and other fuels for London and Northern Ireland in the 2021 release and the 2023 release

The second methodological improvement is to the allocation of emissions to the COICOP category 7.3.5 Combined passenger transport. In previous releases, the passenger transport breakdown for COICOP and its link to the emissions from the input output table follows the allocation shown in Table 6. This was deemed particularly unsatisfactory for London because spend on Oyster cards is allocated to code 7.3.5 'Combined travel', but the carbon multiplier for this type of spend needs to contain emissions from all types of travel, including that associated with cruise ships. This resulted in a multiplier that was too large to accurately describe Oyster card travel (which is not dominated by boat travel) and London ending up with too large a share of the passenger transport footprint.

Table 6: Construction of the passenger transport footprint in 2021 release

7.3 Passenger Transport – 2021 release	Notes
7.3.1 Railway	Includes tube
7.3.2 Road	Ticketed travel - bus not private car
7.3.3 Air	
7.3.4 Water	Ferries and cruises
7.3.5 Combined travel	This is where spend on an Oyster card is recorded This category is also linked to the emissions from ferries and cruises in the input-output table because Oyster covers a small amount of boat travel
7.3.6 Other	Includes spend on storage.

The solution was to combine road and rail travel to a single item and allocate the Oyster card spend there instead (see Table 7).

Table 7: Construction of the passenger transport footprint in 2023 release

7.3 Passenger Transport – 2023 release	Notes
7.3.1_2 Road _Railway	This is now 7.3.1 + 7.3.2 + 7.3.5 so includes spend on Oyster cards but only the emissions from road (bus) and rail
7.3.3 Air	
7.3.4 Other	7.3.4 + 7.3.6 Spend on cruises, ferries and storage.

This has a significant effect on the footprint of passenger travel for London and as Figure 9 reveals the emissions are now a full 1 tonne CO2e per capita lower for the year 2018.

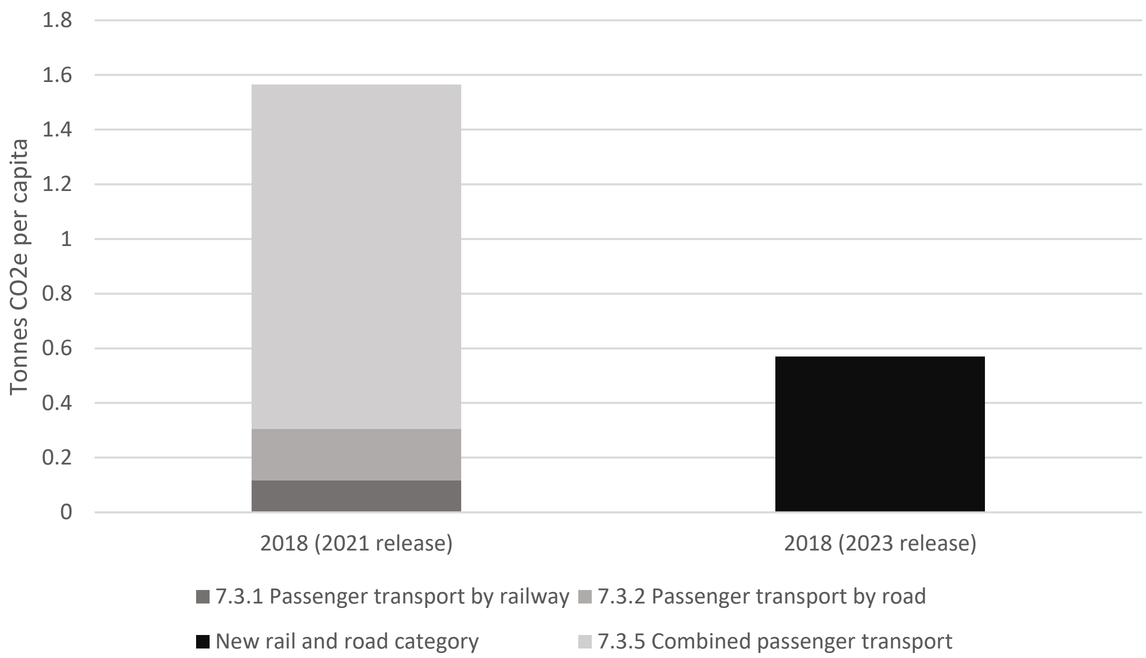

Figure 9: Comparison of emissions associated with rail and road for 2018 in the 2021 and 2023 releases

4.4 A breakdown of Greater London's consumption-based emissions

The average carbon footprint of a resident of Greater London in 2020 was 7.86 tonnes CO2e, compared to 8.56 tonnes in 2019. In Figure 10 we disaggregate this impact into 5 broad household consumption categories (broadly based on the Classification on Individual Consumption According Purpose (COICOP) definition) and a single category for all other non-household consumption (government and capital investment). 16% of the footprint is consumption of transportation products (including public transport, air travel, vehicle purchases and running a car). One quarter of the impact is from heating and powering the home (housing). Food is 8% and goods and services 5% and 11% respectively. The total UK emissions from Government and Capital investment are disaggregated to the local level weighted by population. This means that in 2020, every person in the UK is allocated 2.77 tonnes CO2e and this comprises 35% of the footprint of the average resident of Greater London (Figure 10). The emissions breakdown in 2020 is quite a different picture to 2019 with the COVID-19 pandemic reducing emissions associated with transport substantially.

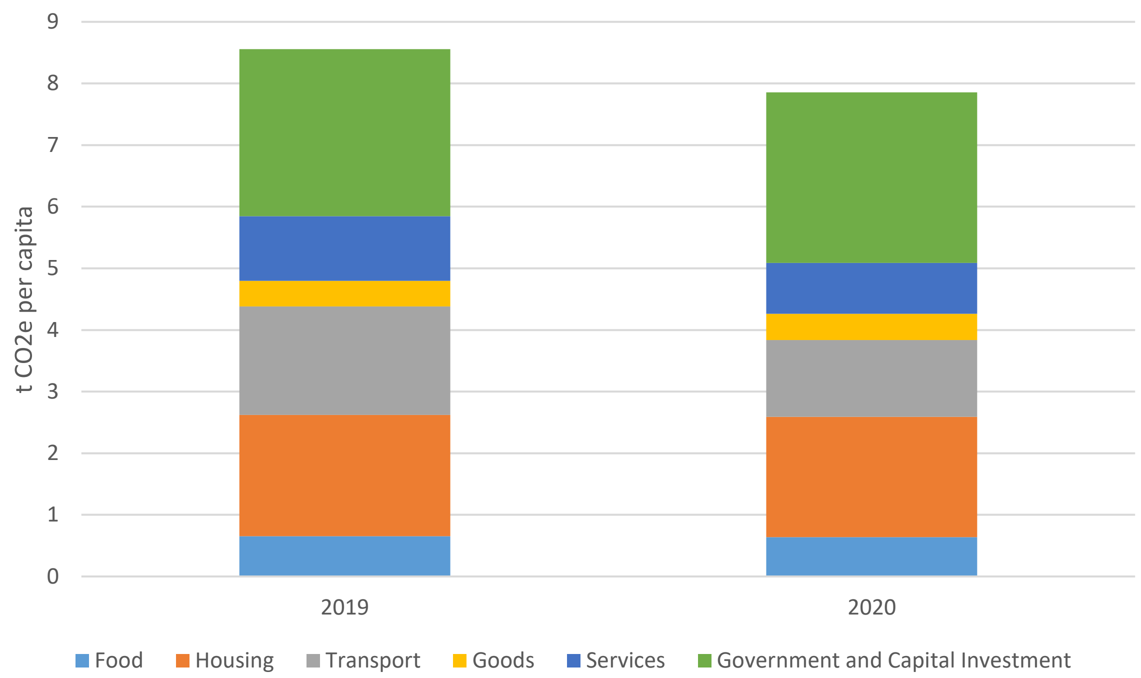

Figure 10: London consumption emissions by final product (2019 and 2020)

4.4.1 How does Greater London compare to other parts of the UK?

In 2001, the average Londoner had a carbon footprint of 13.80 tonnes CO2e (Figure 11). This was around the average for the UK. By 2020, London was the lowest, having experienced the greatest reduction in per capita emissions from consumption (Figure 12).

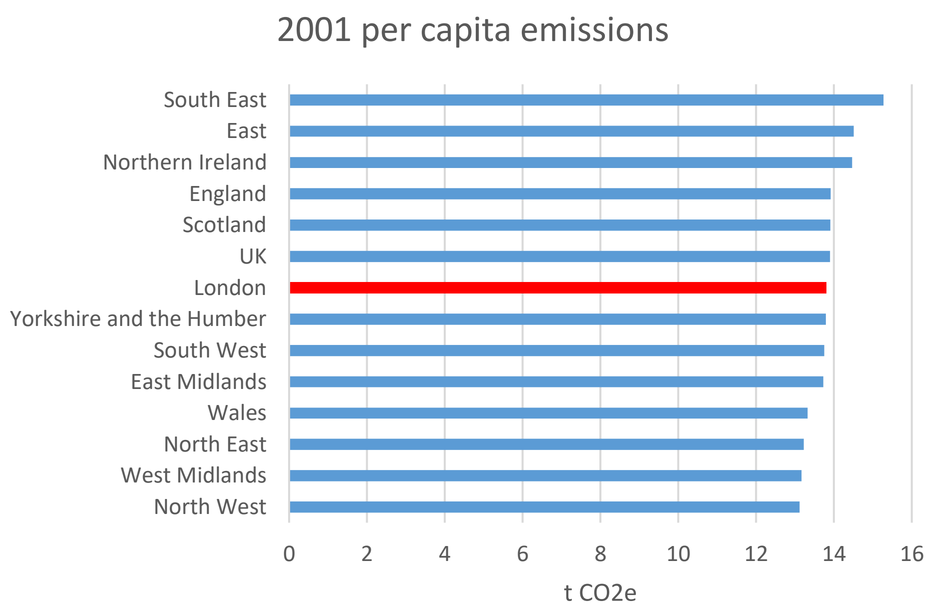

Figure 11: Per capita consumption-based emissions of UK in 2001

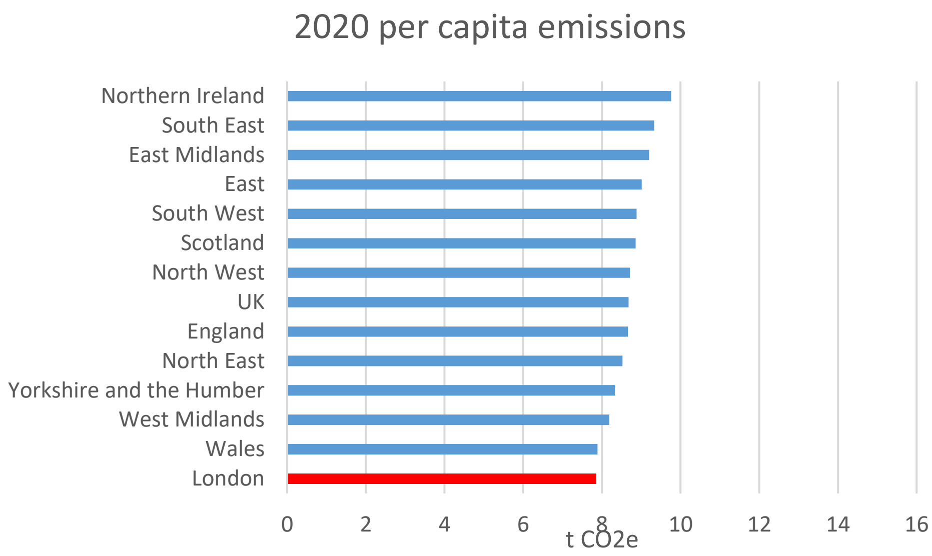

Figure 12: Per capita consumption-based emissions of UK in 2020

4.5 Greater London’s emissions broken down by theme; explanations and comparison with regions

4.5.1 Overall

When comparing London’s results, broken down by the five themes of food, housing, transport, goods and services with results from the other regions in the UK, the data shows that London’s emissions for food, housing, transport and goods are lower than average but the services emissions are larger (Figure 13). This may be a reflection of the different regional restrictions during the COVID-19 pandemic and we urge some caution drawing too many conclusions based on the 2020 results.

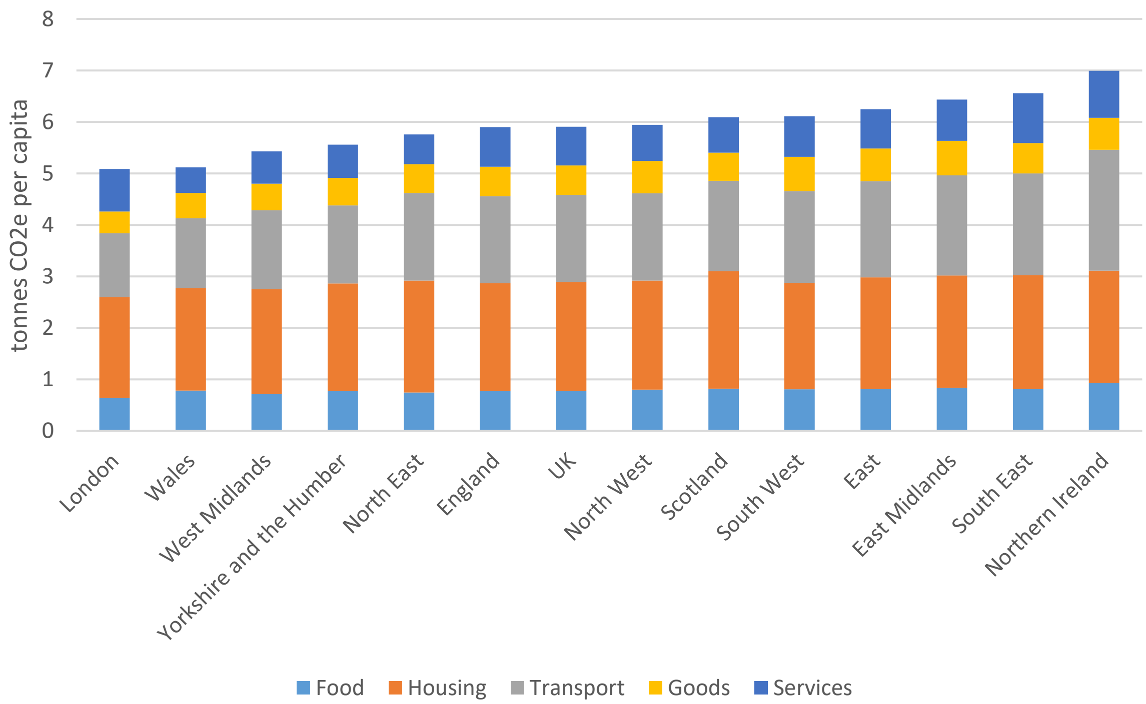

Figure 13: Per capita emissions of UK regions by final product (2020)

4.5.2 Food

The food theme includes the emissions associated with producing, transporting and selling food products to final demand consumers. This means that the emissions associated with flying goods over from abroad is included in the calculations. The food category only includes food purchased for preparation in the home. This means that it includes emissions associated with the materials for making a packed lunch (whether raw or processed) but would not include a meal purchased in a canteen. This theme does not include emissions associated with cooking the food or disposing of it. Gas, electricity and waste sit in the housing theme. The food theme is broken down by eight sub-categories. Table 8 shows which COICOP classes are used.

Table 8: Food breakdown and the COICOP categories used

Food	
Bread and cereals	1.1.1 Bread and cereals
Meat	1.1.2 Meat
Fish and seafood	1.1.3 Fish and seafood
Dairy and eggs	1.1.4 Milk, cheese and eggs
Fruit	1.1.6 Fruit
Vegetables	1.1.7 Vegetables
Beverages	1.2.1 Coffee, tea and cocoa 1.2.2 Mineral waters, soft drinks, fruit and vegetable juices 2.1.1 Spirits 2.1.2 Wine 2.1.3 Beer
Other	1.1.5 Oils and fats 1.1.8 Sugar, jam, honey chocolate and confectionery 1.1.9 Food products not elsewhere classified

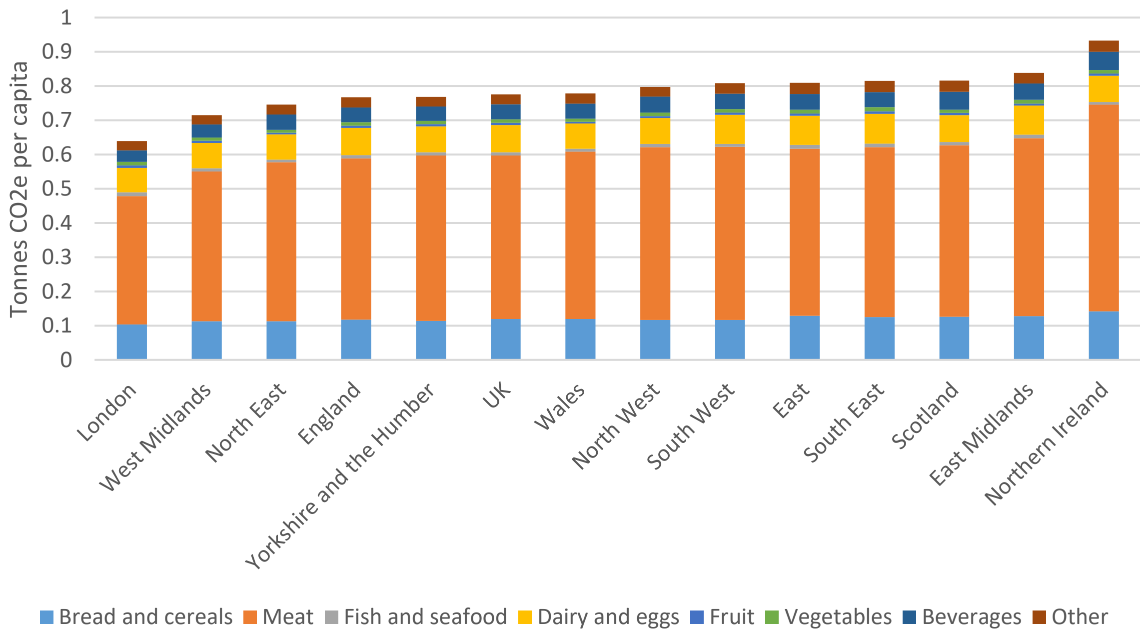

Figure 14: Per capita emissions of UK regions for Food products (2020)

Figure 14 shows the food emissions by region. Meat is the largest contributor. Compared to other regions in the UK, Londoners spend less on meat, which contributes to their lower food footprint.

The per capita emissions associated with Greater London's spend on food are almost exactly the same in 2020 as they were in 2019.

4.5.3 Housing

The housing theme includes the direct and indirect emissions associated with heating and powering the home. This means the emissions from burning, making and transporting the fuel are included. Emissions associated with dealing with waste and products used for maintenance are also included. Mortgage repayments are not part of the national accounts so are not part of the housing footprint calculation (see Section 2.3.1). The housing theme is broken down by five sub-categories. Table 9 shows which COICOP classes are used.

Table 9: Housing breakdown and the COICOP categories used

Housing	
Electricity	4.5.1 Electricity
Gas and other fuels (direct and indirect)	4.5.2 Gas 4.5.3 Liquid fuels 4.5.4 Solid fuels 4.5.5 Heat energy
Water and waste	4.4.1 Water supply 4.4.2 Refuse collection 4.4.3 Sewage collection
Maintenance & repair of the dwelling	4.3.1 Materials for the maintenance and repair of the dwelling 4.3.2 Other services for the maintenance and repair of the dwelling
Other	4.1.1 Actual rentals paid by tenants 4.1.2 Other actual rentals 4.4.4 Other services related to the dwelling not elsewhere classified

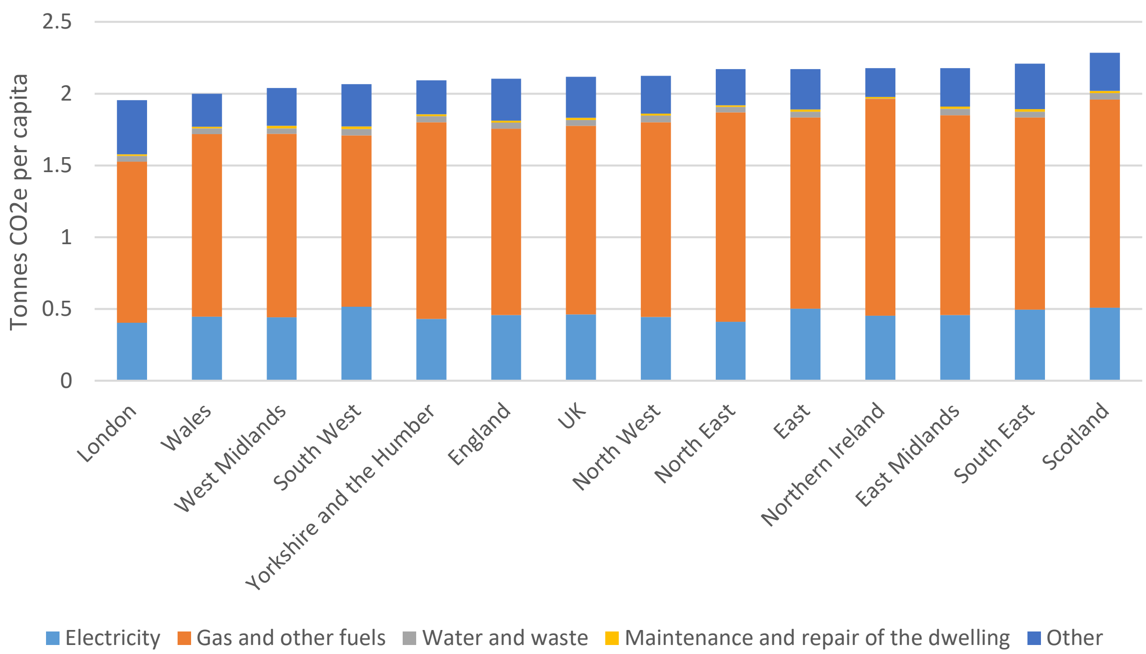

Figure 15: Per capita emissions of UK regions for housing (2020)

Figure 15 shows the housing emissions by region. Compared to other regions in the UK, Londoners spend less on heating and power. This is a function of increased household occupancy rather than lower energy bills and more efficient homes. The average London per capita emissions associated with housing in 2020 are almost the exactly the same as they were in 2019.

4.5.4 Transport

The transport theme includes the direct and indirect emissions from driving personal transport. This means that the emissions from burning, making and transporting the fuel are included. Emissions associated with making personal transport vehicles are also included along with supply chain emissions associated with maintaining and using them, ranging from taxing vehicles, learning to drive, parking fines etc. This theme also includes emissions from using public transport and air travel. A decision was made to group public transport emissions together rather than report rail and bus separately because it is not possible to split the COICOP category '7.3.5 Combined passenger transport' (which contains Oyster card payments) into different transport modes[17]. The three sub-categories and their breakdown are shown in Table 10.

Table 10: Transport breakdown and the COICOP categories used

Transport	
Private transport (direct and indirect)	7.1.1 Motor cars 7.1.2 Motorcycles 7.1.3 Bicycles 7.1.4 Animal drawn vehicles 7.2.1 Spare parts and accessories for personal transport equipment 7.2.2 Fuels and lubricants for personal transport equipment 7.2.3 Maintenance and repair of personal transport equipment 7.2.4 Other services in respect of personal transport equipment
Public transport	7.3.1 Passenger transport by railway 7.3.2 Passenger transport by road 7.3.5 Combined passenger transport
Other transport services	7.3.4 Passenger transport by sea and inland waterway 7.3.6 Other purchased transport services
Aviation	7.3.3 Passenger transport by air

[17] Other datasets such as the London Energy and Greenhouse Gas Inventory (LEGGI) are able to distinguish emissions associated with different modes of transport from Oyster card payments, but we are unable to determine whether these payments are by London residents

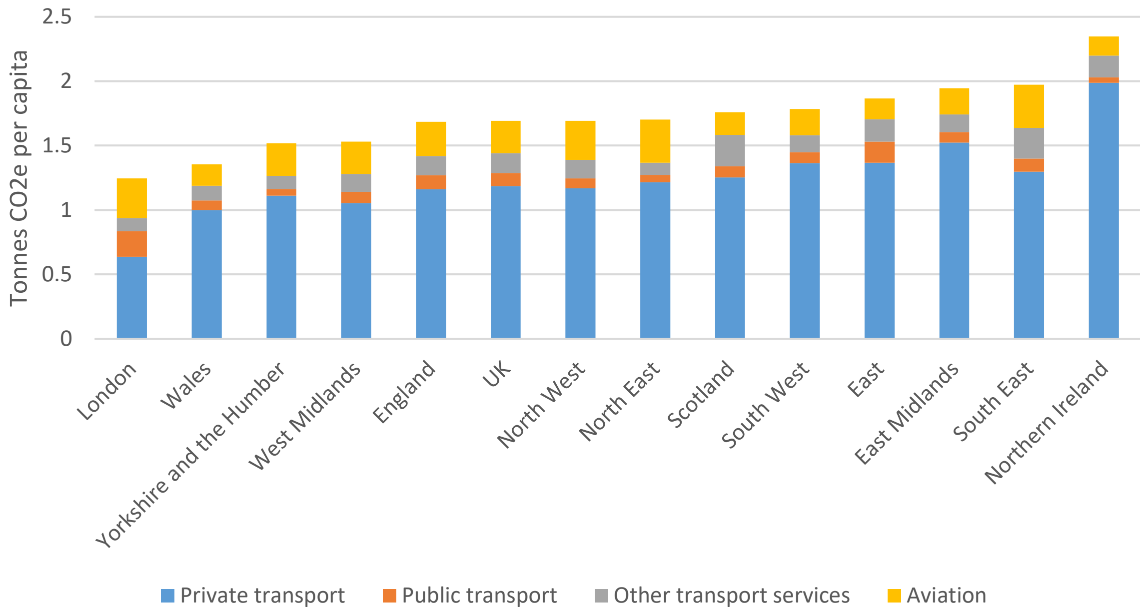

Figure 16: Per capita emissions of UK regions for transport (2020)

Figure 16 shows the transport emissions broken by region. Private transport is usually the largest category. London's use of transport is unlike any other region in the UK. Private transport emissions per capita are much lower than any other regions, and public transport emissions are the highest in the country. However, London also has one of the highest per capita aviation emissions accounts. Transport emissions are unusually low in 2020 due to the COVID19 restrictions. We see a reduction of 29.4% when comparing 2020 per capita transport emissions with 2019. Emissions from spend on public transport have reduced by 45.5% and aviation by 37.3%.

4.5.5 Goods

The goods theme includes the indirect supply chain emissions associated with making goods purchased by final consumers[18]. This category includes the emissions associated with making an appliance but not the emissions that arise from using it or disposing of it. The emissions from electricity used to run an appliance, together with emissions associated with disposal of goods, sit in the Housing theme. Medicines includes emissions associated with any paid for prescriptions but not any drugs received freely on the NHS. Emissions associated with NHS provided products are equally shared by the UK population and are part of Government emissions. Goods includes equipment bought to play sports or undertake hobbies, but any equipment hired or club and gym memberships and tuition fees are found in the services theme. The cost of tickets to see a sporting event is part of services. The Goods theme covers buying pets, pet equipment and pet food, but vet fees are in services. The Goods theme is split into seven categories shown in Table 11.

[18] Transport vehicles are not included in the goods category since they sit with emissions associated with private transport

Table 11: Goods breakdown and the COICOP categories used

Goods	
Clothes	3.1.1 Clothing materials 3.1.2 Garments 3.1.3 Other articles of clothing and clothing accessories 3.1.4 Cleaning, repair and hire of clothing 3.2.1 Shoes and other footwear 3.2.2 Repair and hire of footwear
Furniture and homeware	5.1.1 Furniture and furnishings 5.1.2 Carpets and other floor coverings 5.1.3 Repair of furniture, furnishings and floor coverings 5.2.1 Household textiles 5.4.1 Glassware, tableware and household utensils
Electrical appliances	5.3.1 Major household appliances whether electric or not 5.3.2 Small electric household appliances 5.3.3 Repair of household appliances
Medicines and medical equipment	6.1.1 Pharmaceutical products 6.1.2 Other medical products 6.1.3 Therapeutic appliances and equipment
Hobbies, pets and sports	9.1.1 Equipment for the reception, recording and reproduction of sound and pictures 9.1.2 Photographic and cinematographic equipment 9.1.3 Information processing equipment 9.1.4 Recording media 9.1.5 Repair of audio-visual, photographic and information processing equipment 9.2.1 Major durables for outdoor recreation 9.2.2 Musical instruments and major durables for indoor recreation 9.2.3 Maintenance and repair of other durables for recreation and culture 9.3.1 Games, toys and hobbies 9.3.2 Equipment for sport, camping and open-air recreation 9.3.3 Gardens, plants and flowers 9.3.4 Pets and related products
Paper and stationery	9.5.1 Books 9.5.2 Newspapers and periodicals 9.5.3 Miscellaneous printed matter 9.5.4 Stationery and drawing materials
Other	2.2.1 Tobacco 5.5.1 Major tools and equipment 5.5.2 Small tools and miscellaneous accessories 5.6.1 Non-durables household goods 5.6.2 Domestic services and household services 12.1.2 Electrical appliances for personal care 12.1.3 Other appliances, articles and products for personal care 12.3.1 Jewellery, clocks and watches 12.3.2 Other personal effects

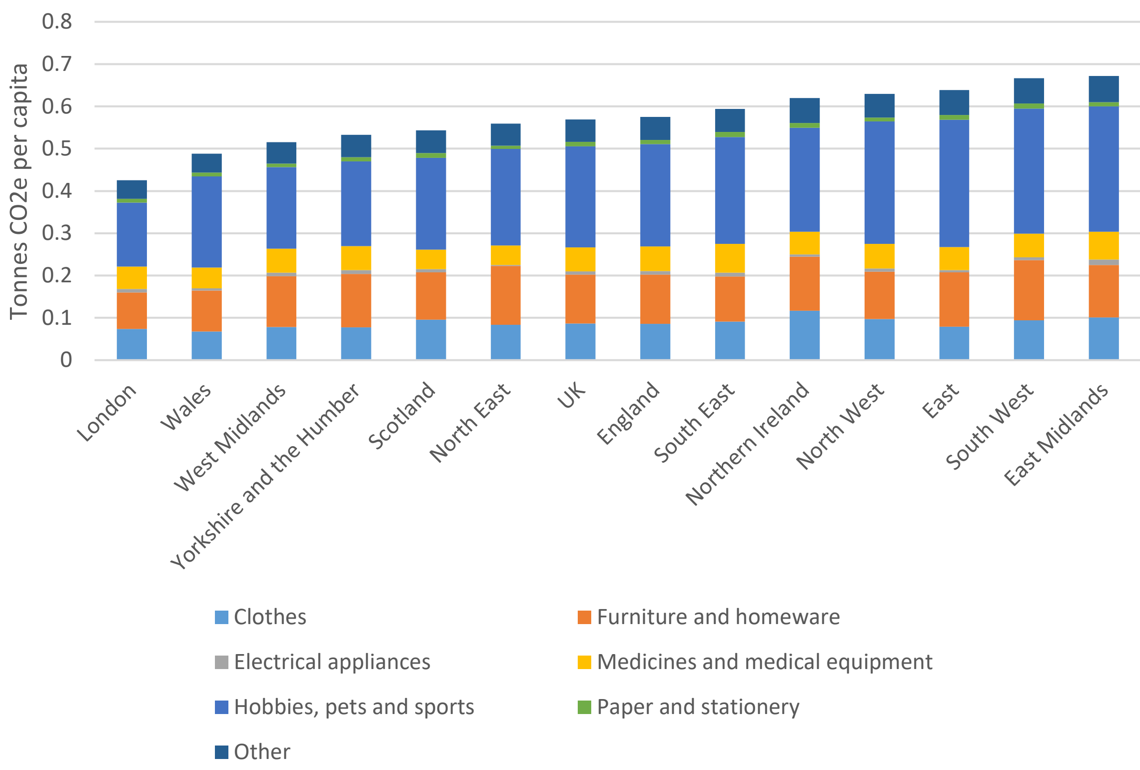

Figure 17: Per capita emissions of UK regions for goods (2020)

Figure 17 shows the goods emissions broken down further. Hobbies, pets and sports is the usually the largest category, followed by furniture and homeware. London has the lowest average goods footprint in the country. The spend on hobbies, pets and sports is particularly low. The average emissions from a London resident's goods expenditure is very slightly higher in 2020 than it was in 2019, with the increase found in the hobbies, pets and sports category.

4.5.6 Services

The services theme covers the indirect supply chain emissions associated with providing a service purchased by final consumers. For health and education, emissions can only be calculated when they are associated with a household spend. State education and the NHS is mostly divided equally by the UK population and is part of the Government emissions. Money used for school trips, private education and private health care is included in this theme. Pre-school education is part of the Education category but nursery fees are included in 'other' since the category 12.4.1 covers childminding, day-care, nursery and retirement homes. It was decided to include both the cost of mobile phone equipment (8.2.1) and the cost of making calls (8.3.1) in services because so many mobile contracts include the cost of buying the phone in the monthly service fee. The services theme is split into seven categories and is shown in Table 12.

Table 12: Services breakdown and the COICOP categories used

Services	
Healthcare	6.2.1 Medical services 6.2.2 Dental services 6.2.3 Paramedical services 6.3.1 Hospital services
Communication	8.1.1 Postal services 8.2.1 Telephone and telefax equipment 8.3.1 Telephone and telefax services

Education	10.1.1 Pre-primary and primary education 10.2.1 Secondary education 10.3.1 Post-secondary non-tertiary education 10.4.1 Tertiary education 10.5.1 Education not definable by level
Restaurants and cafes	11.1.1 Restaurants, cafes and the like 11.1.2 Canteens
Hotels	11.2.1 Accommodation services
Finance and insurance	12.5. Insurance 12.6.2 Other financial services not elsewhere classified
Other	9.3.5 Veterinary and other services for pets 9.4.1 Recreational and sporting services 9.4.2 Cultural services 9.4.3 Games of chance (Gambling and the lottery) 12.1.1 Hairdressing salons and personal grooming establishments 12.4.1 Social protection 12.7.1 Other services not elsewhere classified

Figure 18 shows the services emissions broken down further. Restaurants and cafes are the largest category, followed by finance and insurance and other. Restaurants is large due to the amount of food waste involved in preparing restaurant food and the fact that this covers both the food preparation and the emissions associated with running the business. London's spend on services is one of the highest in the UK and it has the highest spend on restaurants and cafes and education. The emissions associated with services reduced by 21.1% for the average London resident between 2019 and 2020. This reduction of 0.2 tonnes CO2e per person was mainly from reductions in spend on private healthcare and restaurants and cafes.

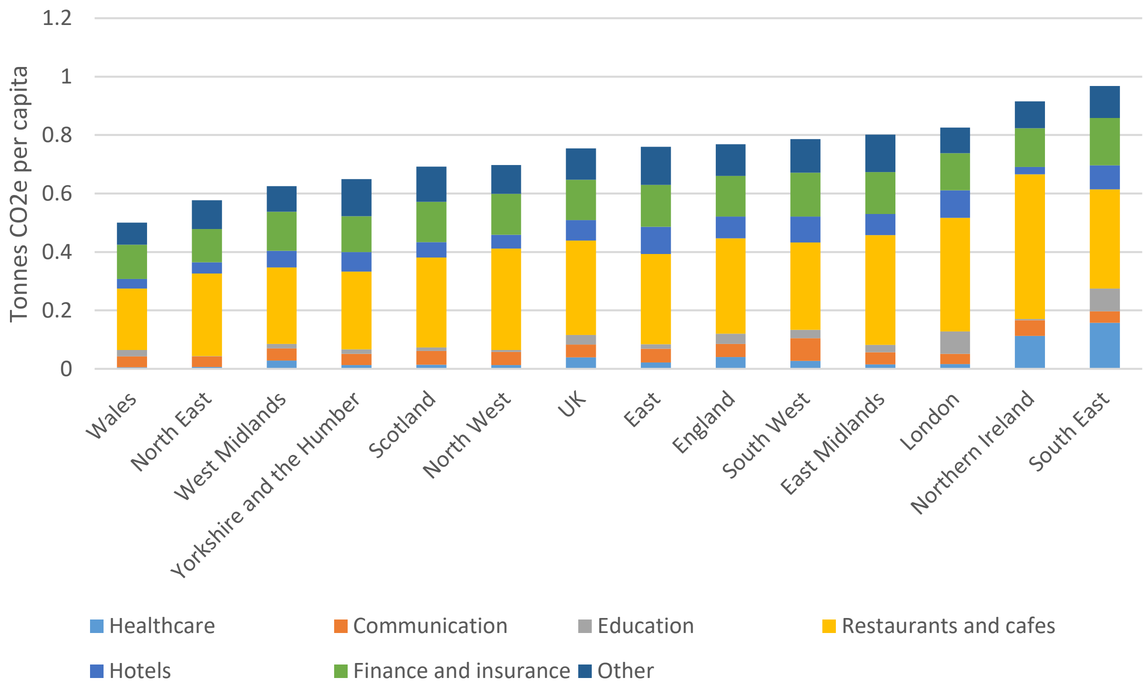

Figure 18: Per capita emissions of UK regions for services (2020))

4.5.7 Government and capital investment

As previously explained, every London borough will have the same per capital emissions associated with Government expenditure and capital investment. In 2020, emissions associated with Government spend equated to 1.51 tonnes CO2e per person. This was an increase of 20% from 2019. Emissions associated with capital investment are 1.26 tonnes CO2e per person in 2020. This was a decrease of 14% from 2019[19].

4.6 London breakdown by borough

Every London borough has seen a reduction in their total CBA between 2001 – 2020, with Kensington and Chelsea reducing by the largest proportion (39.9%) and City of London reducing by the smallest (9.5%). However, when taking into account London's population growth over the period, the reductions are even more significant. On a per capita basis, Redbridge has seen the largest reduction (49.6%) and Kensington and Chelsea the least (35.4%), although all boroughs fall within a similar range. Figure 19 reveals that the per capita reductions are broadly similar.

[19] A recent C40 report calculates that buildings and infrastructures represent 11% of C40 cities' consumption-based account. We calculate that in 2020, capital investment is 16% of a London resident's consumption-based account but note that this is based on an average share of UK capital investment emissions and is not specific to the city of London https://www.arup.com/perspectives/publications/research/section/the-future-of-urban-consumption-in-a-1-5c-world

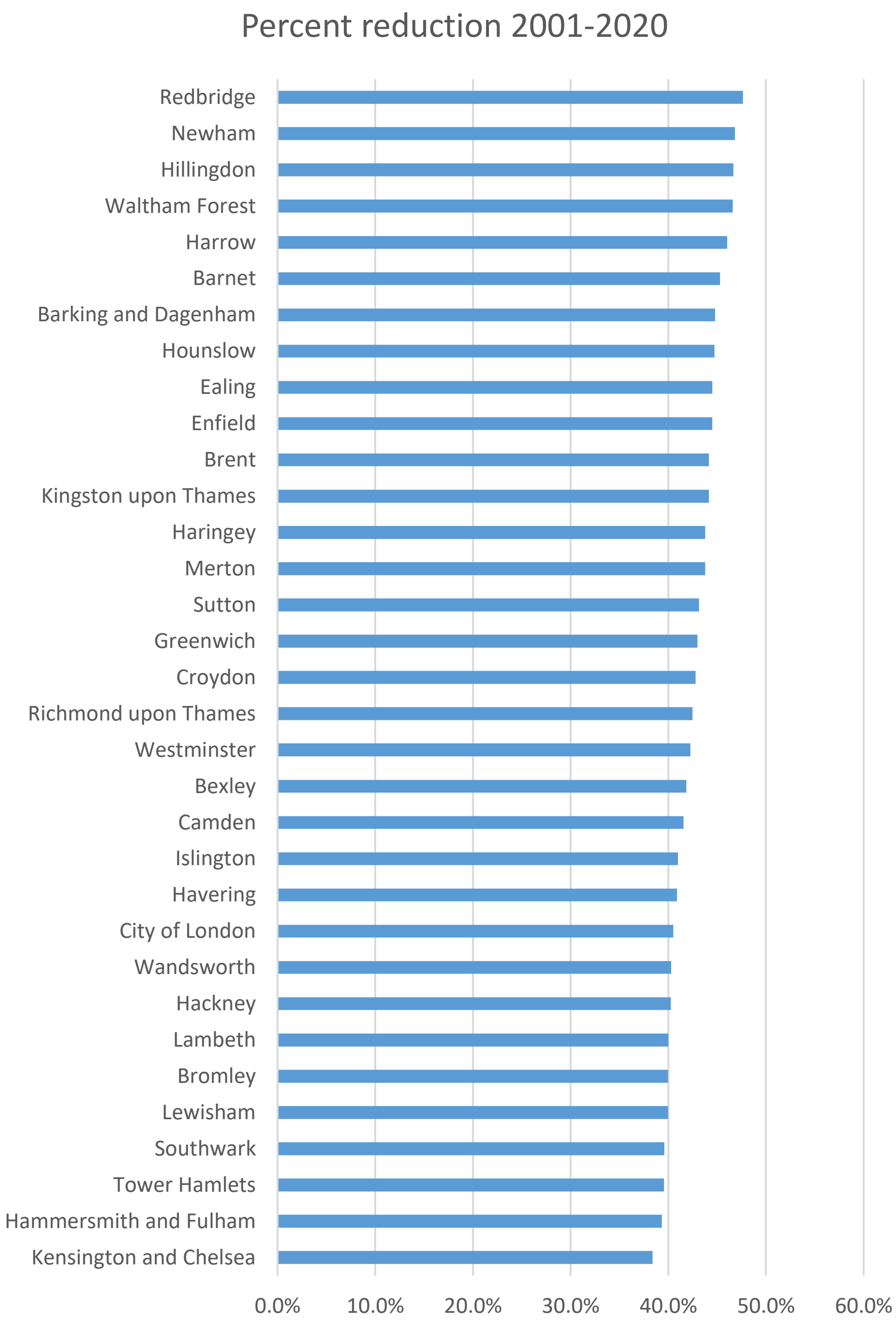

Figure 19: Percentage reductions in per capita consumption-based emissions (2001-2020)

In addition to seeing overall reductions in CBA emissions per capita, the variation in impact has reduced over the time-period. By 2020, the differences between the boroughs with the highest and smallest CBE per capita reduced and we see the standard deviation reduce from 1.15 tonnes in 2001 and 0.77 tonnes in 2020 (Table 13). Despite the reduction in differences, we still see a difference of 3.33 tonnes CO2e between the largest and smallest per capita footprints in 2020.

Table 13: Summary statistics for 2001 and 2020

	Tonnes CO2e per capita	2001	2020
All (households, Government and capital investment)	Max	16.42 Richmond upon Thames	9.64 City of London
	Min	11.17 Tower Hamlets	6.31 Newham
	Standard deviation	1.15	0.77

The breakdown of CBA by high level product groups is broadly similar for all boroughs in 2020 (Figure 20).

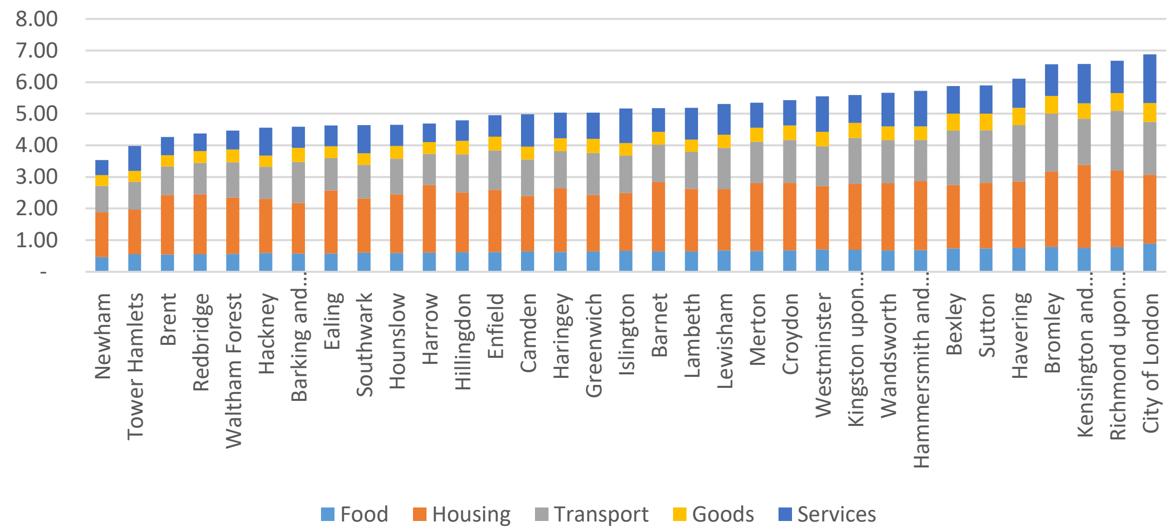

Figure 20: Per capita emissions of London boroughs by final product (2020)

Table 14

			Tonnes CO2e per capita (2020)
Food	Max	City of London	0.89
	Min	Newham	0.46
Housing	Max	Kensington and Chelsea	2.63
	Min	Tower Hamlets	1.41
Transport	Max	Richmond upon Thames	1.90
	Min	Newham	0.83
Goods	Max	City of London	0.60
	Min	Newham	0.34
Services	Max	City of London	1.54
	Min	Newham	0.48

In every borough, the item with the largest impact is housing, followed by transport. Housing has the largest range (1.22 tonnes) in per capita emissions, from 2.63 tonnes in Kensington and Chelsea to 1.41 tonnes in Tower Hamlets. The range (1.07 tonnes) of values for transport is between 1.90 tonnes in Richmond upon Thames and 0.83 in Newham.

In London, services makes up 11% of an average household CBA. In the wealthier areas of the City of London and Kensington and Chelsea, a greater proportion of impact associated with restaurants is seen compared to the average. In general, the wealthy areas have larger than average impacts, driven by spends on goods such as clothing, air travel, recreation and other services.

5 Conclusions, recommendations and next steps

5.1 Overall findings

The University of Leeds has successfully developed a robust and replicable methodology to calculate the consumption-based GHG account of all 32 London Boroughs, the City of London and Greater London. The results show that household consumption emissions have reduced significantly across all boroughs in the period 2001-2020. However further action is needed to reach targets at the borough, regional and national level. This project finds that major areas of consumption are broadly consistent across boroughs – emissions from transport, housing & power and services represent the majority of a household CBA. There is some variation across the boroughs with the richest boroughs having the highest impact for non-essential consumption items like hotels and restaurant spend. Caution is recommended when using results at the more granular levels where there is potential for noise in the data but there is confidence that the overall trends accurately indicate the direction of travel in emissions.

The results presented provide an important local level picture for how boroughs and the region can focus efforts to reduce emissions in line with adopted targets. These results can help the boroughs and the region check progress towards the One World Living consumption-based emissions reduction target of a two-thirds by 2030 and prioritise areas for action.

5.2 Comment on methodology, data sources and update

The methodology used ensures that the sum of the London boroughs plus the City of London equals the reported CBA for Greater London. The data used to disaggregate Greater London's CBA to the individual borough level is free, open source and annually updated. Now that the methodology has been established, updating the dataset for 2021 should be a relatively straight forward process. The UKMRIO database will be updated in early 2024 and will be capable of reporting the UK CBA for 1990-2021. This data will be published in Spring 2024. Once this data is published, the 2021 Greater London, borough and City of London results will be processed.

2021 was a census year, which means there will be a new 2021 Output Area Classification and any changes to an area's character can be reflected. It takes a number of years for the census to be processed and for a new OAC to be finalised. It is unlikely that a 2021 OAC will be reflected in the LCFS until 2024 at the earliest. In addition, the UKMRIO database is always 3 years out of date due to the time it takes to update the National Accounts. This means that the effects of a new OAC will not be seen until publication of 2024 in 2027.

It is important to note that the underlying model, the UKMRIO database, is completely updated each year and the entire time series is re-estimated to reflect any updates to data sources and methodological improvements. This means that results for 2001-2021 may be re-estimated in 2024 and change slightly. This will affect the London CBA and it is recommended that the entire time series is re-estimated each year, rather than simply reporting the next additional year.

5.3 Recommendation for wider coverage

This project has demonstrated that it is possible to disaggregate CBA for the UK regions down to the local authority level. The data used for the London boroughs is available for all the other regions in

England, Wales and Scotland. This means it is simple to produce results datasheets for all local authorities in England, Wales and Scotland. The OAC is not recorded for Northern Irish households in the LCFS so an alternate approach would need to be developed to disaggregate CBA in Northern Ireland.

London Councils, in collaboration with the GLA and ReLondon, has led the way in commissioning data on consumption-based emissions accounts for the boroughs and the City of London. As accounting for emissions from consumption continues to move up the political agenda, and the UK starts to consider how to develop targets for consumption-based emissions reductions, it is likely that more and more local councils will request consumption-based emissions estimates. These results will only be meaningful if developed in a manner consistent with the national level results. This project strongly recommends that this London case study becomes the blueprint for the rest of the country.

6 References

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7 Appendix

7.1 Guide to using the datasets – a focus on Harrow

An Excel dataset has been produced for each of the 32 London Boroughs, the City of London and Greater London. The first sheet (see Figure 21) is a menu of the type of data that can be viewed for the specific local area.

Harrow **Consumption-based household emissions**

UNIVERSITY OF LEEDS

Produced by University of Leeds

Workbook Contains

1 Dashboard
2 Food (2001-2020)
3 Housing (2001-2020)
4 Transport (2001-2020)
5 Goods (2001-2020)
6 Services (2001-2020)
7 Govt & Cap Investment (2001-2020)
8 Summary themed (2001-2020)
9 Index change
10 Comparison by theme
11 Start of datasets

Figure 21: The overview sheet in the borough level dataset

The remainder of the dataset is as follows:

1. **Dashboard**: a summary sheet showing headline results for the borough or Greater London
2. **Food (2001-2020)**: a timeline of emissions from a more detailed set of food categories for the chosen area and a comparison for 2020 for the rest of the boroughs or rest of the regions
3. **Housing (2001-2020)**: a timeline of emissions from a more detailed set of housing categories for the chosen area and a comparison for 2020 for the rest of the boroughs or rest of the regions
4. **Transport (2001-2020)**: a timeline of emissions from a more detailed set of transport categories for the chosen area and a comparison for 2020 for the rest of the boroughs or rest of the regions
5. **Goods (2001-2020)**: a timeline of emissions from a more detailed set of goods categories for the chosen area and a comparison for 2020 for the rest of the boroughs or rest of the regions
6. **Services (2001-2020)**: a timeline of emissions from a more detailed set of services categories for the chosen area and a comparison for 2020 for the rest of the boroughs or rest of the regions
7. **Govt & Cap Inv (2001-2020)**: a timeline of emissions from government and capital investment for the chosen area
8. **Summary themed (2001-2020)**: the CBA broken down by 5 high-level consumption categories (food, housing, transport, good and services)
9. **Index change**: chart showing relative change from 2001 of the 5 high-level consumption categories together with government and capital investment
10. **Comparison by theme (2001-2020):** sheet showing 6 per capita household CBA charts for each of the high-level consumption categories, for the borough, Greater London and UK
11. **Start of the datasheets**: the core detailed datasheets used in the construction of the results

The following sections present a deep dive into Harrow's results, as an example of how to interpret the data.

7.1.1 Total and per capita emissions time series

The first two charts on the dashboard show the time series of total consumption-based emissions for Harrow and a comparison of the per capita emissions with London as a whole and the whole of the UK. Comparing the blue line for Harrow on Figure 22 and Figure 23 reveals how population growth effects the emissions estimate and that the per capita reduction is steeper. Harrow has a similar CBA to London as a whole and the UK. Most of the reduction in emissions occurred between 2008 and 2011 and 2015 and 2020. Country-wide, large reductions in emissions are seen during the 2007-2009 recession and more recently due to decarbonisation of the electricity sector and the COVID-19 pandemic.

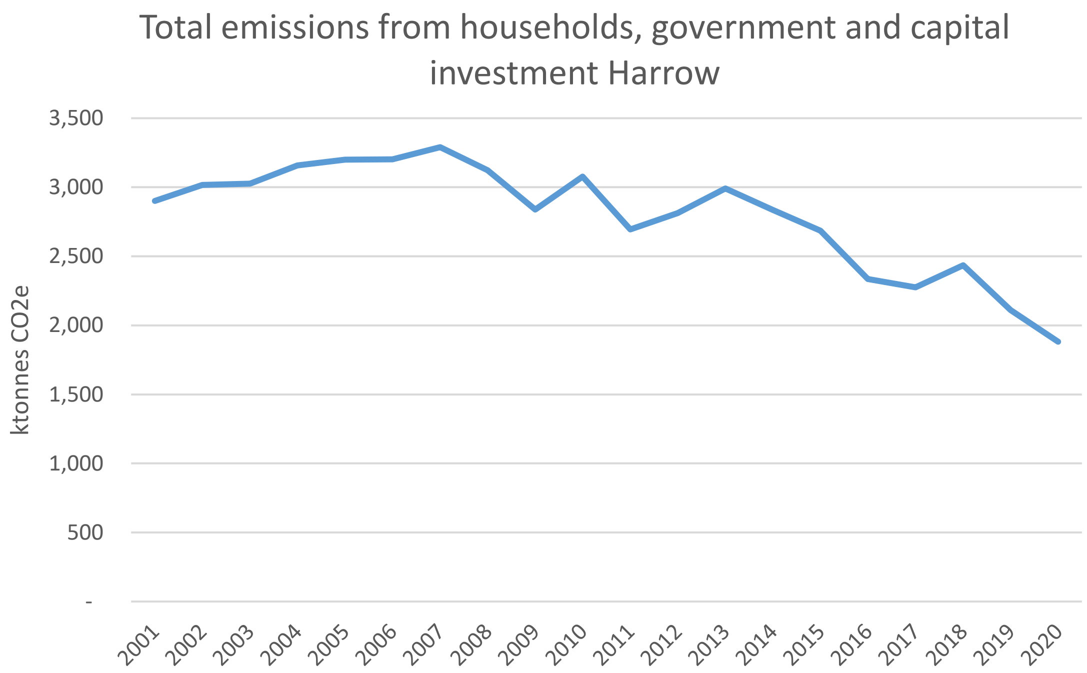

Figure 22: Total emissions for Harrow 2001-2020

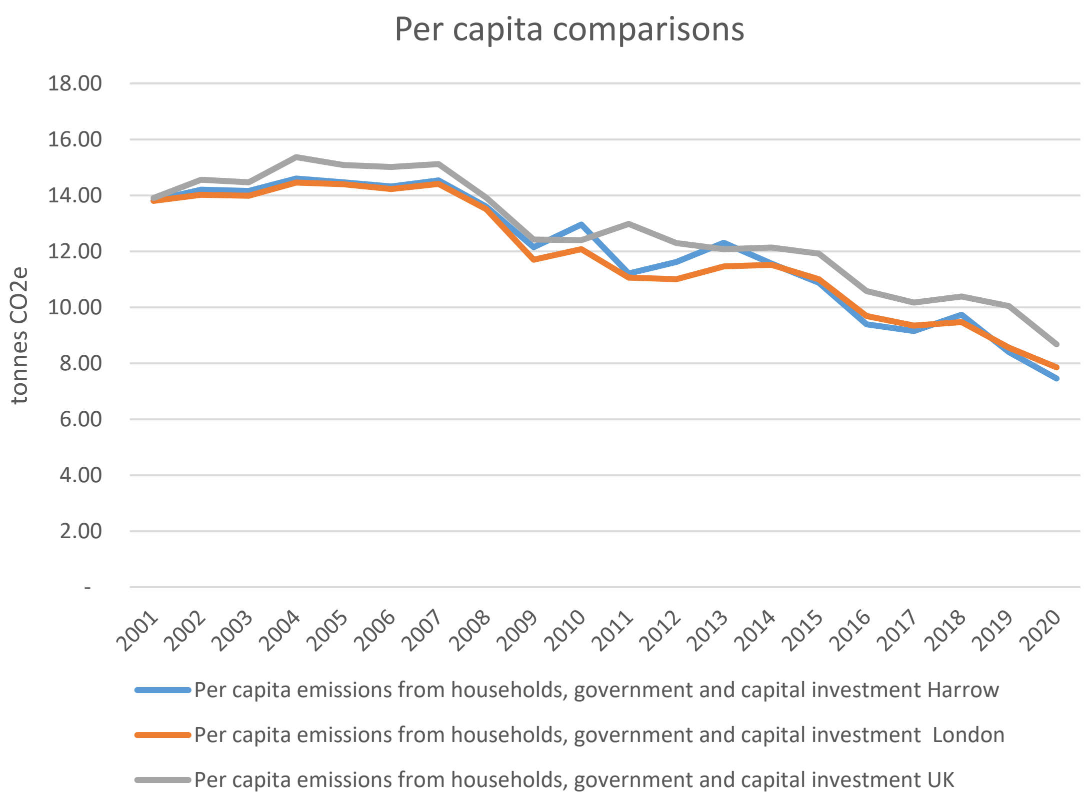

Figure 23: Per capita household emission for Harrow, London and the UK 2001-2020

7.1.2 Emissions breakdown by source and final product

The third chart on the dashboard shows the total household CBA for Harrow broken down in two different ways:

- Where in the world the emissions were released to meet consumption by Harrow residents?
- Which final products are the emissions embodied in?

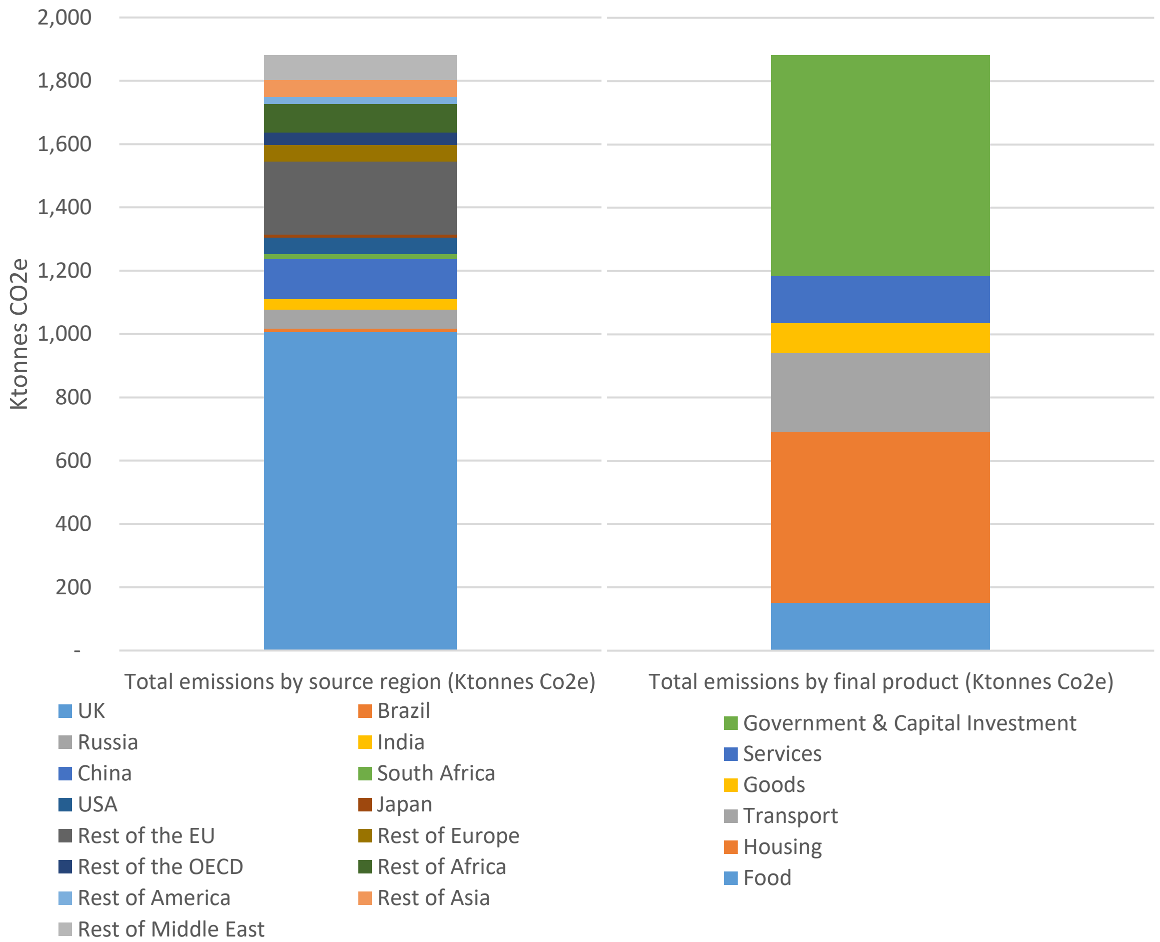

Figure 24: Breakdown of total Harrow HCBA by source and final product (2020)

The greatest proportion of emissions associated with Harrow's household consumption are released in the UK. This is due to the large proportion of consumption associated with home heating and personal transport. A further 12% are emissions from the EU. The right-hand chart in Figure 24 is the same breakdown shown in Figure 10. These type of breakdown charts can be useful in order to understand where emissions reduction policy should focus.

For example, in Harrow, policy makers may consider targeting emissions from the three largest consumption areas: transport, housing and food. They can also look at the more detailed levels of data and target private transport or meat consumption specifically. The breakdown shows that targeting emissions associated with household spend on services will not be associated with a large reduction.

7.1.3 Product based comparisons with the UK and London

The next chart on the dashboard (Figure 25) allows the user to compare the average levels of consumption in the borough with averages for the whole of the UK and the whole of London. The chart is a propensity chart (therefore unitless) with the UK and London set at 100 and the borough level is compared to this index level. For example, Harrow has a level of 78 for food, meaning that the average household in Harrow spends 78 per cent of the UK average for this product type and consequently has a lower-than-average impact for this category of spend. For housing, Harrow has a level of 110 compared to London, meaning that residents of Harrow spend and have an impact 10% higher than the average London resident for this category of spend.

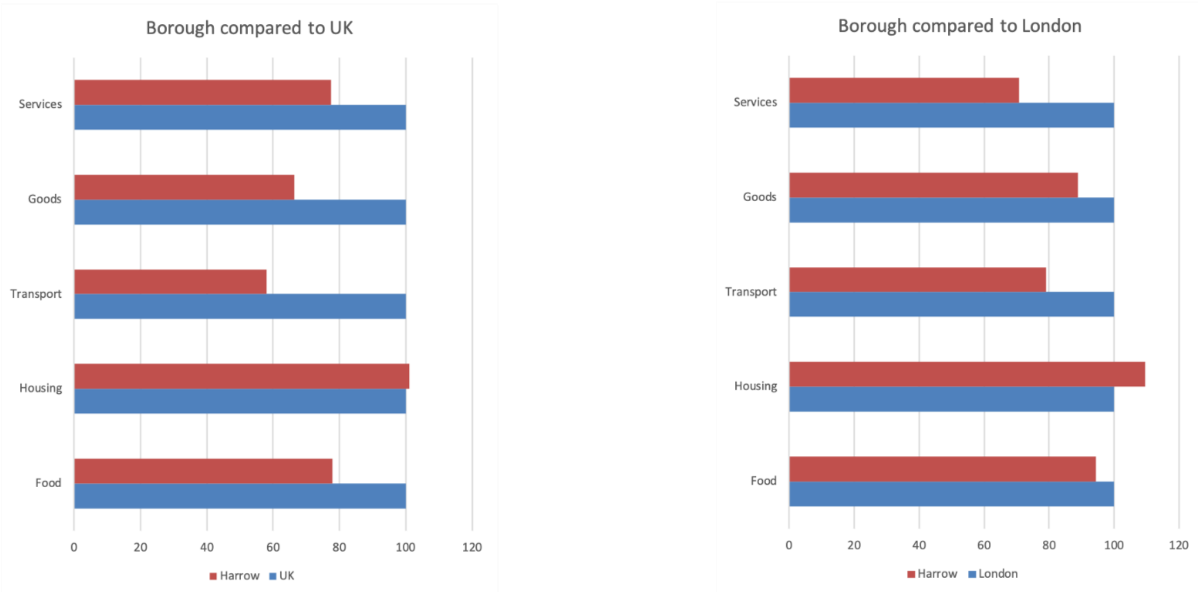

Figure 25: Product based comparisons for Harrow with the UK and London (2020) (base = 100)

This type of data can be useful in understanding why a borough has a lower or higher than average impact compared to London or the UK. Because Harrow has a higher-than-average impact for housing, the policy maker may want to investigate if this could be due to a less-than-average efficiency of housing stock. Looking at the data in sheets 2-6 can reveal which particular consumption items are contributing to high or low emissions associated with a particular theme. In particular, the CBA can reveal areas of large supply chain impacts associated with restaurant expenditure for example. This is not covered in the LEGGI/territorial accounts.

7.1.4 Ranked comparisons with the rest of London

The next few charts in the dashboard compare per capita results for Harrow with the other London boroughs and the City of London. The borough of Harrow is highlighted in orange.

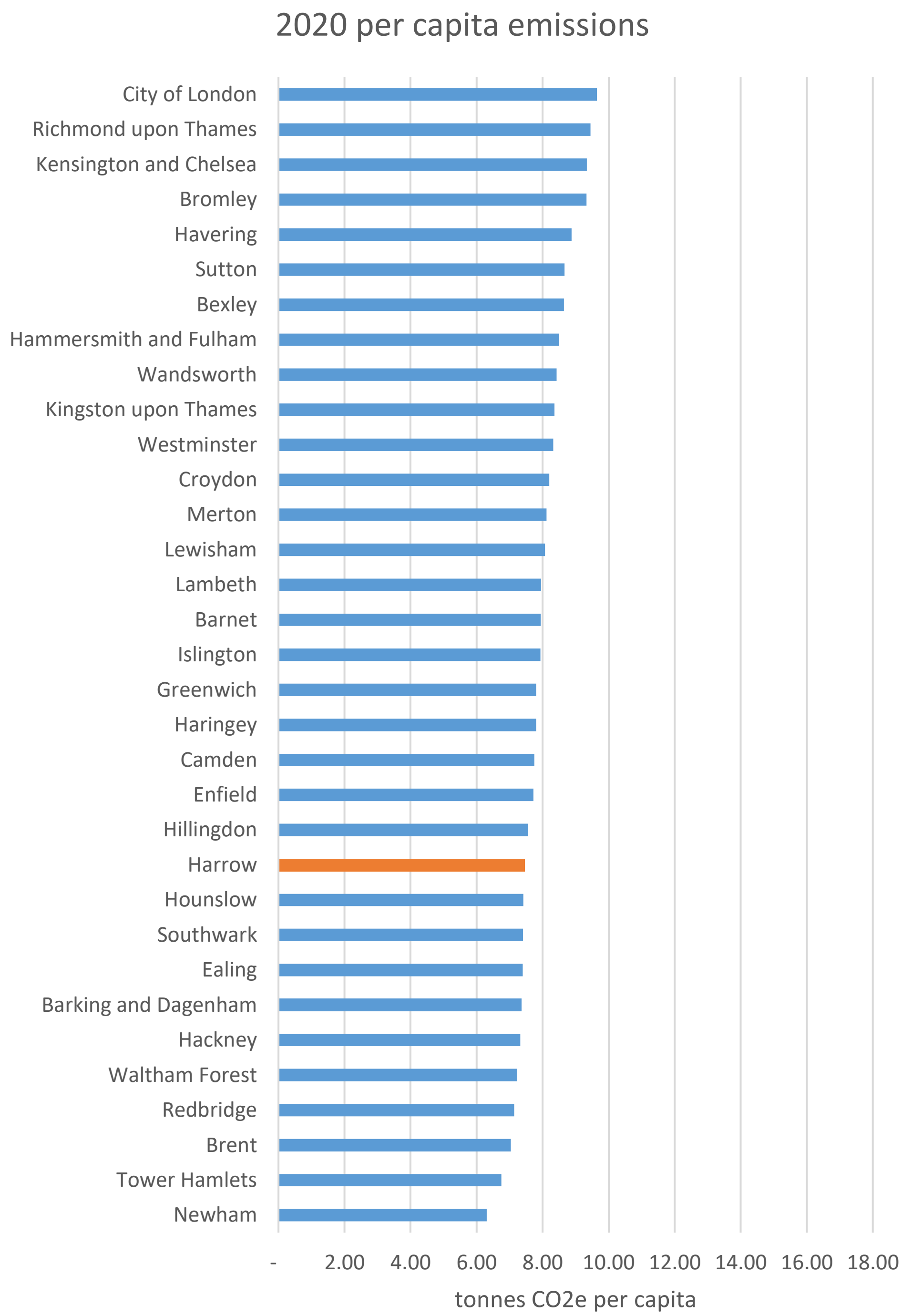

Figure 26: Per capita results comparing the borough of Harrow with the other London boroughs and the City of London (2020)

Ranked charts can be useful when comparing two boroughs with similar characteristics but different household emissions profiles. Are there two boroughs with similar levels of wealth but very different housing and power impacts? Comparing the borough rankings over time might reveal information about how some areas have changed and some have not.

7.1.5 Product-based time-series comparisons and a note on noise in the data

Sheet 10, Comparison by Theme, reveals how the per capita impact for the borough has changed over time for 5 high-level product groups. A comparison with the London and UK averages is also shown. Figure 27 shows that Harrow's food impact per capita is lower than the UK average.

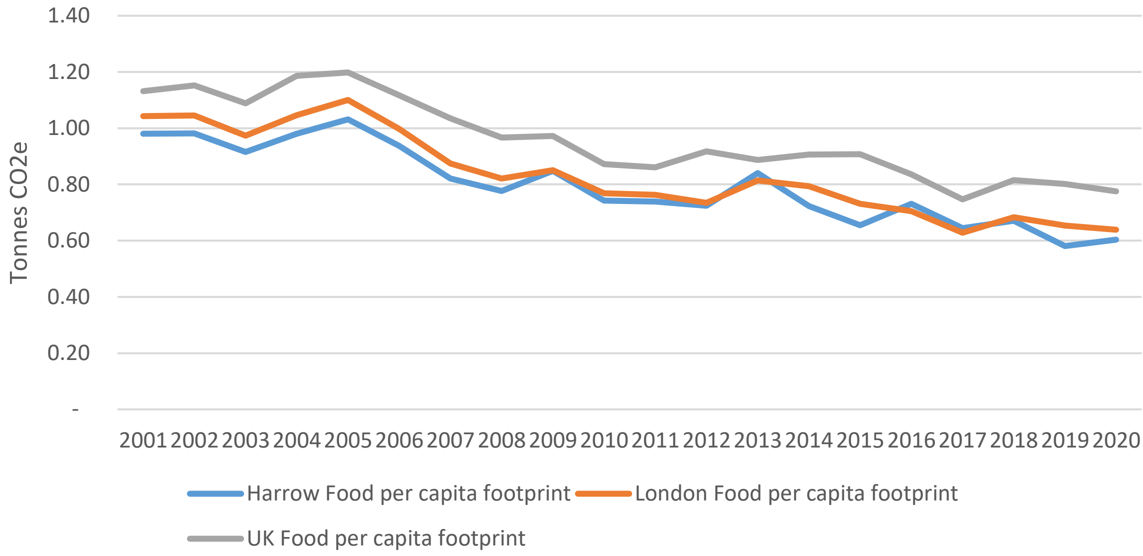

Figure 27: Per capita food and non-alcoholic drinks HCBA for Harrow, London and UK (2001-2020)

Note that the UK data is a relatively smooth line, whereas London, then the borough get progressively more jagged. A more extreme example of this can be seen in Figure 28, the goods impact chart, where there is a spike in 2003.

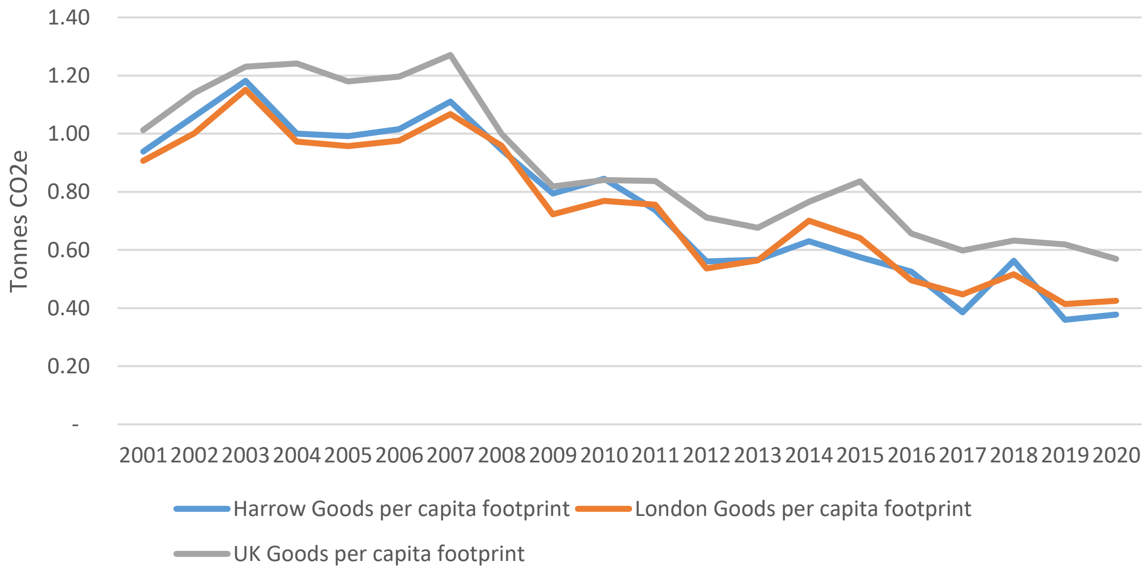

Figure 28: Per capita health HCBA for Harrow, London and UK (2001-2020)

This irregularity or noise further demonstrates how the aggregated data is more accurate than the disaggregated values. The UK trend for goods is smooth and it gets more erratic the smaller the geography. The reason for this is that goods expenditure in the LCFS can be sporadic spend (for example spend on white goods) – not something that every household spends money on every week.

7.1.6 Advanced level analysis

Further sheets in the back end of the spreadsheet allow for further breakdown of the results. For example, sheet 'ghg_2001_reg' shows the source emission region by product type in the year 2001. Here you can determine that three quarters of the emissions associated with household appliances are imported, for example.

7.2 Input-output analysis

The Leontief Input-Output model is constructed from observed economic data and shows the interrelationships between industries that both produce goods (outputs) and consume goods (inputs) from other industries in the process of making their own product (Miller & Blair, 2009).

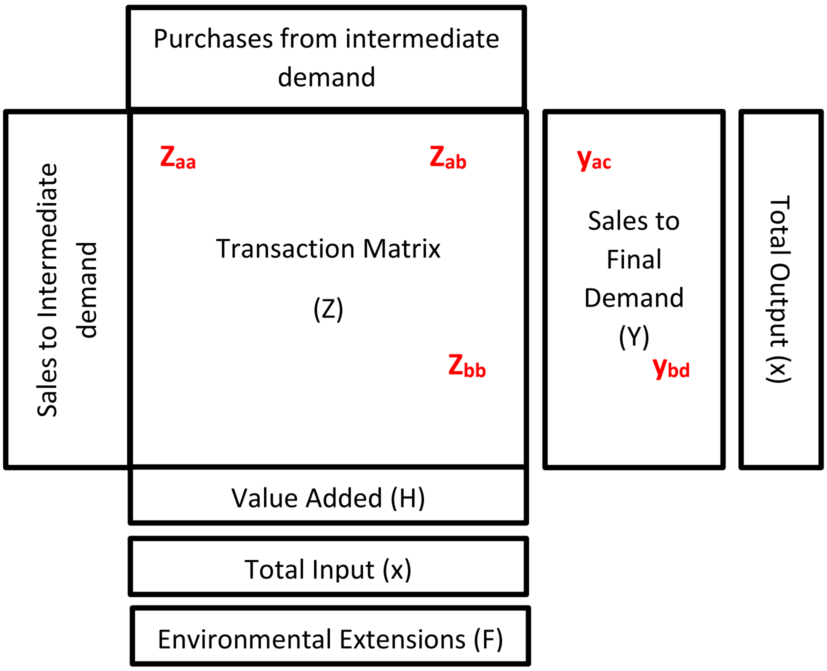

Figure 29: Basic structure of a Leontief Input-Output Model

Consider the transaction matrix $\mathbf{Z}$; reading across a row reveals which industries a single industry sells to and reading down a column reveals who a single industry buys from. A single element, $\mathbf{z}_{ij}$, within $\mathbf{Z}$, represents the contributions from the i^{th} sector to the j^{th} industry or sector in an economy. For example, $\mathbf{z}_{aa}$ represents the ferrous metal contribution in making ferrous metal products, $\mathbf{z}_{ab}$, the ferrous metal contribution to car products and $\mathbf{z}_{bb}$ the car production used in making cars. Final demand is the spend on finished goods. For example, $\mathbf{y}_{ac}$ is the spend on ferrous metal products by households as final consumers whereas $\mathbf{y}_{bd}$ is the spend on car products by government as final consumers.

The total output ($\mathbf{x}_i$) of a particular sector can be expressed as:

$$\mathbf{x}_{i=}\mathbf{z}_{i1} + \mathbf{z}_{i2} + \cdots + \mathbf{z}_{ij} + \mathbf{y}_i \qquad (1)$$

where $\mathbf{y}_i$ is the final demand for that product produced by the particular sector. If each element, $\mathbf{z}_{ij}$, along row i is divided by the output $\mathbf{x}_i$, associated with the corresponding column j it is found in, then each element in $\mathbf{Z}$ can be replaced with:

$$\mathbf{a}_{ij} = \frac{\mathbf{z}_{ij}}{\mathbf{x}_j} \qquad (2)$$

to form a new matrix $\mathbf{A}$.

Substituting for (2) in equation (1) forms:

$$\mathbf{x_{i=}a_{i1}x_1 + a_{i2}x_2 + \cdots + a_{ij}x_i + y_i} \qquad (3)$$

Which, if written in matrix notation is $= \mathbf{Ax} + \mathbf{y}$ *.* Solving for $\mathbf{y}$ gives:

$$\mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{y} \qquad (4)$$

where $\mathbf{x}$ and $\mathbf{y}$ are vectors of total output and final demand, respectively, $\mathbf{I}$ is the identity matrix, and $\mathbf{A}$ is the technical coefficient matrix, which shows the inter-industry requirements. $(\mathbf{I} - \mathbf{A})^{-1}$ is known as the Leontief inverse (further identified as $\mathbf{L}$). It indicates the inter-industry requirements of the i^{th} sector to deliver a unit of output to final demand. Since the 1960s, the IO framework has been extended to account for increases in the pollution associated with industrial production due to a change in final demand (Kitzes, 2013).

Consider, a row vector $\mathbf{f}$ of annual GHG emissions generated by each industrial sector

$$\mathbf{e} = \mathbf{f}\hat{\mathbf{x}}^{-1} \qquad (5)$$

is the coefficient vector representing emissions per unit of output[20]. Multiplying both sides of (4) by $\mathbf{e}'$ gives

$$\mathbf{e}'\mathbf{x} = \mathbf{e}'\mathbf{Ly} \qquad (6)$$

and simplifies to

$$\mathbf{F} = \mathbf{e}'\mathbf{Ly} \qquad (7)$$

where $\mathbf{F}$ is the GHG emissions in matrix form allowing consumption-based emissions to be determined. $\mathbf{F}$ is calculated by pre-multiplying $\mathbf{L}$ by emissions per unit of output and post-multiplying by final demand. This system can be expanded to the global scale by considering trade flows between every industrial sector in the world rather than within a single country. This type of system requires a multi-regional input –output (MRIO) table (Peters et al., 2011).

To calculate the emissions associated with a subset of the total region, the final demand vector $\mathbf{y}$ is replaced with the final demand corresponding to the area of focus. For example, if the final demand vector $\mathbf{y\_harrow}$ is used which shows final demand by product for households in Harrow, the calculation $\mathbf{F} = \mathbf{e}'\mathbf{Ly\_harrow}$ will give the consumption-based account for Harrow's households

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[20] $\hat{}$ denotes matrix diagonalisation and $'$ denotes matrix transposition

7.3 Output area classifications for 2001 and 2011

Table 15: 2001 OAC Supergroups

	Supergroup name
1	Blue Collar Communities
2	City Living
3	Countryside
4	Prospering Suburbs
5	Constrained by Circumstances
6	Typical Traits
7	Multicultural

Table 16: 2001 OAC Groups

	Group name
1a	Terraced Blue Collar
1b	Younger Blue Collar
1c	Older Blue Collar
2a	Transient Communities
2b	Settled in the City
3a	Village Life
3b	Agricultural
3c	Accessible Countryside
4a	Prospering Younger Families
4b	Prospering Older Families
4c	Prospering Semis
4d	Thriving Suburbs
5a	Senior Communities
5b	Older Workers
5c	Public Housing
6a	Settled Households
6b	Least Divergent
6c	Young Families in Terraced Homes
6d	Aspiring Households
7a	Asian Communities
7b	Afro-Caribbean Communities

Table 17L 2001 OAC Subgroups

	Subgroup name
1a1	Terraced Blue Collar 1
1a2	Terraced Blue Collar 2
1a3	Terraced Blue Collar 3
1b1	Younger Blue Collar 1
1b2	Younger Blue Collar 2
1c1	Older Blue Collar 1
1c2	Older Blue Collar 2
1c3	Older Blue Collar 3
2a1	Transient Communities 1

2a2	Transient Communities 2
2b1	Settled in the City 1
2b2	Settled in the City 2
3a1	Village Life 1
3a2	Village Life 2
3b1	Agricultural 1
3b2	Agricultural 2
3c1	Accessible Countryside 1
3c2	Accessible Countryside 2
4a1	Prospering Younger Families 1
4a2	Prospering Younger Families 2
4b1	Prospering Older Families 1
4b2	Prospering Older Families 2
4b3	Prospering Older Families 3
4b4	Prospering Older Families 4
4c1	Prospering Semis 1
4c2	Prospering Semis 2
4c3	Prospering Semis 3
4d1	Thriving Suburbs 1
4d2	Thriving Suburbs 2
5a1	Senior Communities 1
5a2	Senior Communities 2
5b1	Older Workers 1
5b2	Older Workers 2
5b3	Older Workers 3
5b4	Older Workers 4
5c1	Public Housing 1
5c2	Public Housing 2
5c3	Public Housing 3
6a1	Settled Households 1
6a2	Settled Households 2
6b1	Least Divergent 1
6b2	Least Divergent 2
6b3	Least Divergent 3
6c1	Young Families in Terraced Homes 1
6c2	Young Families in Terraced Homes 2
6d1	Aspiring Households 1
6d2	Aspiring Households 2
7a1	Asian Communities 1
7a2	Asian Communities 2
7a3	Asian Communities 3
7b1	Afro-Caribbean Communities 1
7b2	Afro-Caribbean Communities 2

Table 18: 2011 OAC Supergroups

	Supergroup name
1	Rural residents
2	Cosmopolitans

3	Ethnicity central
4	Multicultural metropolitans
5	Urbanites
6	Suburbanites
7	Constrained city dwellers
8	Hard-pressed living

Table 19: 2011 OAC Groups

	Group name
1a	Farming communities
1b	Rural tenants
1c	Aging rural dwellers
2a	Students around campus
2b	Inner city students
2c	Comfortable cosmopolitan
2d	Aspiring and affluent
3a	Ethnic family life
3b	Endeavouring Ethnic Mix
3c	Ethnic dynamics
3d	Aspirational techies
4a	Rented family living
4b	Challenged Asian terraces
4c	Asian traits
5a	Urban professionals and families
5b	Ageing urban living
6a	Suburban achievers
6b	Semi-detached suburbia
7a	Challenged diversity
7b	Constrained flat dwellers
7c	White communities
7d	Ageing city dwellers
8a	Industrious communities
8b	Challenged terraced workers
8c	Hard pressed ageing workers
8d	Migration and churn

Table 20L 2011 OAC Subgroups

	Subgroup name
1a1	Rural workers and families
1a2	Established farming communities
1a3	Agricultural communities
1a4	Older farming communities
1b1	Rural life
1b2	Rural white-collar workers
1b3	Aging rural flat tenants
1c1	Rural employment and retirees
1c2	Renting rural retirement

1c3	Detached rural retirement
2a1	Student communal living
2a2	Student digs
2a3	Students and professionals
2b1	Students and commuters
2b2	Multicultural student neighbourhoods
2c1	Comfortable cosmopolitan
2c2	Migrant commuters
2c3	Professional service cosmopolitans
2d1	Urban cultural mix
2d2	Highly-qualified quaternary workers
2d3	EU white-collar workers
3a1	Established renting families
3a2	Young families and students
3b1	Striving service workers
3b2	BanGreater Londondeshi mixed employment
3b3	Multi-ethnic professional service workers
3c1	Constrained neighbourhoods
3c2	Constrained commuters
3d1	New EU tech workers
3d2	Established tech workers
3d3	Old EU tech workers
4a1	Social renting young families
4a2	Private renting new arrivals
4a3	Commuters with young families
4b1	Asian terraces and flat
4b2	Pakistani communities
4c1	Achieving minorities
4c2	Multicultural new arrivals
4c3	Inner city ethnic mix
5a1	White professionals
5a2	Multi-ethnic professionals with families
5a3	Families in terraces and flats
5b1	Delayed retirement
5b2	Communal retirement
5b3	Self-sufficient retirement
6a1	Indian tech achievers
6a2	Comfortable suburbia
6a3	Detached retirement living
6a4	Ageing in suburbia
6b1	Multi-ethnic suburbia
6b2	White suburban communities
6b3	Semi-detached ageing
6b4	Older workers and retirement
7a1	Transitional Eastern European neighbourhoods
7a2	Hampered aspiration
7a3	Multi-ethnic hardship
7b1	Eastern European communities
7b2	Deprived neighbourhoods
7b3	Endeavouring flat dwellers

7c1	Challenged transitionaries
7c2	Constrained young families
7c3	Outer city hardship
7d1	Ageing communities and families
7d2	Retired independent city dwellers
7d3	Retired communal city dwellers
7d4	Retired city hardship
8a1	Industrious transitions
8a2	Industrious hardship
8b1	Deprived blue-collar terraces
8b2	Hard pressed rented terraces
8c1	Ageing industrious workers
8c2	Ageing rural industry workers
8c3	Renting hard-pressed workers
8d1	Young hard-pressed families
8d2	Hard-pressed ethnic mix
8d3	Hard-pressed European Settlers