CONSUMPTION-BASED GREENHOUSE GAS EMISSIONS FOR LONDON (2001-2018)

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1 Introduction

This report was commissioned by the Greater London Authority to understand the total impact that Londoners have on greenhouse gas emissions, including those that take place outside London's physical boundaries. This is important in order to tackle the climate emergency.

This report documents the Consumption-based Greenhouse Gas Emissions Accounts (CBA) for London for the period of 2001 to 2018. CBA offers a different perspective from the standard approach for assigning GHG emissions to a territory. Instead of purely considering the emissions that are released in the territory of London, CBA considers the emissions that occur due to the consumption activities of London residents, including all the emissions associated with the production of goods and services throughout their complete supply chain (more detailed definitions are provided below).

University of Leeds is responsible for producing the CBA for the UK Government and Scottish Government providing national level figures. The same methodology has been applied to calculate the CBA for London. 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 greenhouse gas emissions.

The UK has adopted consumption-based emissions as an official government indicator and has published numerous reports using this indicator to evaluate the effectiveness of climate mitigation measures beyond technological solutions. These include an assessment of the role of resource efficiency in climate change mitigation policy, the role of services and an understanding of drivers of GHG emissions between 1992 and 2004.

In summary, employing the EE-MRIO methodology and ensuring consistency with the national accounting, this report provides consumption-based emissions for London for 2001 through to 2018, for both Carbon Dioxide and Greenhouse Gases, providing figures in absolute and per capita emissions. This study replaces previous estimates of London's CBA.

2 Definitions

Greenhouse gas (GHG) emissions can be allocated to a country or region in different ways: (I) territorial-based, (II) production-based, and (III) consumption-based emission reporting.

2.1 Territorial Emissions

The United Nations Framework Convention on Climate Change (UNFCCC) requires countries in 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, however, 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 Business, Energy and Industrial Strategy (BEIS) reports these emissions as the UK's Greenhouse Gas Inventory and they form the basis for reporting on progress towards our domestic and international emissions reduction targets. In this report, we call this account "**territorial-based emission inventories**".

2.2 Production Emissions

In official reporting to Eurostat[1], 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, but exclude 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, we call these "**production-based emission inventories**".

2.3 Consumption Emissions

Consumption-based emissions allocate emissions to the consumers in each country, usually based on final consumption as in the SNA but also as trade-adjusted emissions (Peters, 2008). Conceptually, consumption-based inventories can be thought of as 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, Foot and Rural Affairs (Defra) publishes the consumption-based emissions calculated by the University of Leeds. In this report, we call these "**consumption-based emission inventories**" or "the Carbon Footprint".

Table 1 provides a simplified view of what is included and excluded in each emissions account.

[1] The statistical office of the European Union

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			
industries owned by UK, located in UK making products consumed by RoW			
industries owned by RoW, located in UK making products consumed by UK			
industries owned by RoW, located in UK making products consumed by RoW			
industries owned by UK, located in RoW making products consumed by UK			
industries owned by UK, located in RoW making products consumed by RoW			
industries owned by RoW, located in RoW making products consumed by UK			
industries owned by RoW, located in RoW making products consumed by RoW			
bunker aviation & shipping owned by UK and used by UK residents			
bunker aviation & shipping owned by RoW and used by UK residents			
bunker aviation & shipping owned by UK and used by RoW residents			
bunker aviation & shipping owned by RoW and used by RoW residents			
UK citizens' activities within UK territory			
RoW citizens' activities within UK territory			
UK citizens' activities within RoW territory			
RoW citizens' activities within RoW territory			
land use, land use change and forestry			

2.4 Composition of the GHGs

For the 2021 release of the UK consumption-based account we are able to include the full suite of GHGs as reported to the UNFCCC. These are:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Hydro-flourocarbons (HFC)
- Perflurocarbons (PFC)
- Nitrogen trifluoride (NF_3)
- Sulphur hexafluoride (SF_6) all measured in kilotonnes CO_2e

This means that the CBA for London will also contain this full suite of GHGs.

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. The Leontief Input-Output (IO) 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.

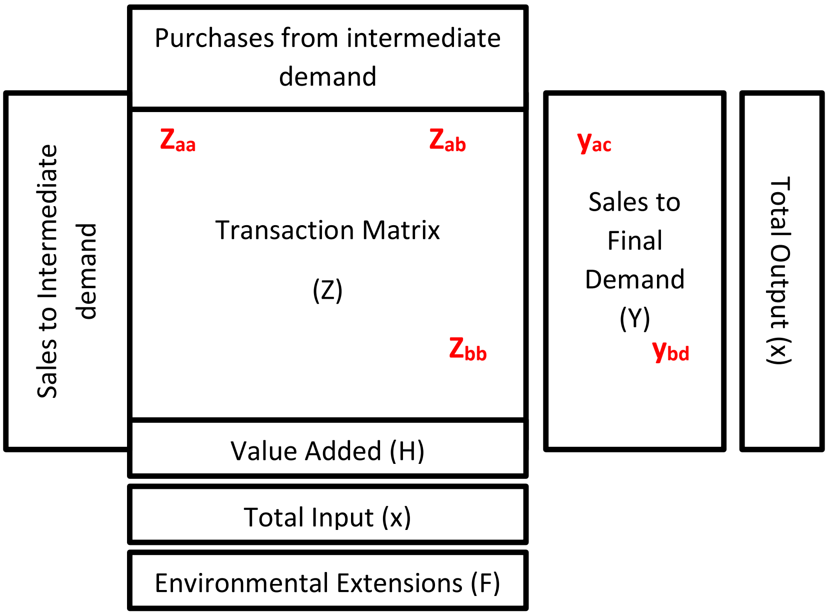

Figure 1: Basic structure of a Leontief Input-Output Model

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, 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 (x_i) of a particular sector can be expressed as:

$$\mathbf{x_i = z_{i1} + z_{i2} + \cdots + z_{ij} + y_i} \quad (1)$$

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

$$\mathbf{a_{ij}} = \frac{\mathbf{z_{ij}}}{\mathbf{x_j}} \quad (2)$$

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

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

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

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.

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[2]. 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 industry in the world rather than within a single country. This type of system requires a multi-regional input–output (MRIO) table.

To calculate the emissions associated with a subset of the total, 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 $\mathbf{y\_london}$ is used which shows final demand by product for households in the GLA, the calculation $\mathbf{F} = \mathbf{e}'\mathbf{Ly\_london}$ will give the consumption-based account for London's households.

3.2 Data sources

This project will use the University of Leeds' UKMRIO model but the household final demand vectors for London will need to be constructed. Essentially, we need to calculate what proportion of the total UK household spend London is responsible for, for each consumption item contained in the database. For example, if households in London spend 30% of the total UK household spend on clothing, it will receive 30% of the total UK household footprint associated with clothing. To understand the portion of UK households' spend by product attributed to London we will use two approaches:

Firstly, for domestic consumption of gas and electricity we will use the 'Regional and local authority consumption statistics' produced by BEIS which give estimates of gas and electricity consumption for the years 2005-2018. We will convert the data into proportions (i.e. what proportion of the total gas and electricity use for the UK is London using) and use trend projections to project the data back to 2001. Home energy use represents around ¼ 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.

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

Finally, for all other consumption, we will construct spend profiles using the Living Costs and Food Survey (LCFS). Since 1957, the Office for National Statistics (ONS) has annually surveyed UK households on their weekly expenditure. In 2008 this survey became known as the Living Costs and Food Survey. The LCFS achieves a sample of around 6,000 UK households and is used to provide information on 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)), additional 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 2018 release, a weight is supplied to indicate the proportion of UK households that are represented by this profile. For example, the 1st household in the 2018 survey has a weight of 4,576 meaning that 4,576 households in the UK are represented by this survey. The sum of every weight is 27 million – the total number of households in the UK. The LCFS is available in a format that is comparable for the years 2001-2018. This means that results for the devolved regions start from 2001.

Table 2: Number of surveys from households in London in the LCFS 2001-2018

Year	Number of London Surveys in the LCFS
2001	678
2002	605
2003	639
2004	631
2005	601
2006	540
2007	528
2008	472
2009	464
2010	476
2011	536
2012	490
2013	480
2014	407
2015	427
2016	414
2017	437
2018	433

Since the LCFS collects information on the household's Government Office Region, we can easily construct a spend profile for all households in London. We then calculate the proportion of spend by product that London spends compared to the UK total. Multiplying these proportions by total UK footprint by product disaggregates the consumption-based GHG emissions for the UK down to Greater London. This method ensures that the sum of the regions equals the total footprint. Table 2 shows that the number of surveys from London households ranges from 678 in 2001 to 407 in 2014.

4 Results

4.1 Overall results

Figure 1 shows the consumption-based GHG emissions for London between 2001 and 2018 on an absolute basis. This is broken down by the high-level categories of government, capital, households and other. 'Capital' represents business investment in physical assets such as infrastructure, construction and machinery and 'Government' represents emissions associated with services provided by governmental organisations. It is important to note that 'Government' is not the scope 1,2 and 3 emissions of the Greater London Authority. It is the average per capita emissions associated with services proved by all UK Governmental institutions (national and local).

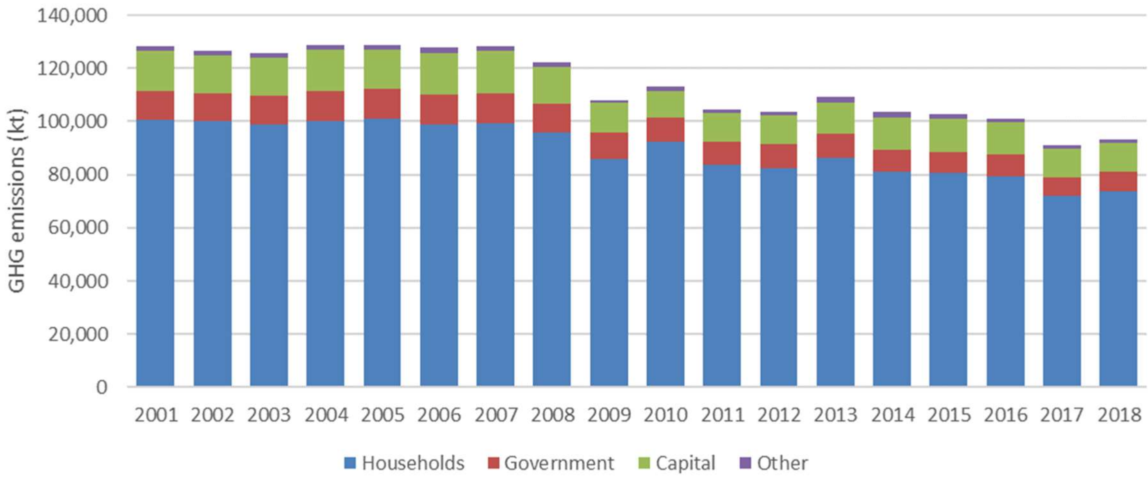

Figure 2: London total GHG footprint broken down by final demand type (2001-2018)

The total GHG footprint of London has declined by 27% over the 18-year period. From a per capita perspective, the reduction is higher due to population growth (18% increase over the same period), with a total reduction of 39%. The majority of this reduction occurred between 2008 and 2009, during the global financial crisis which had a profound effect on household expenditure.

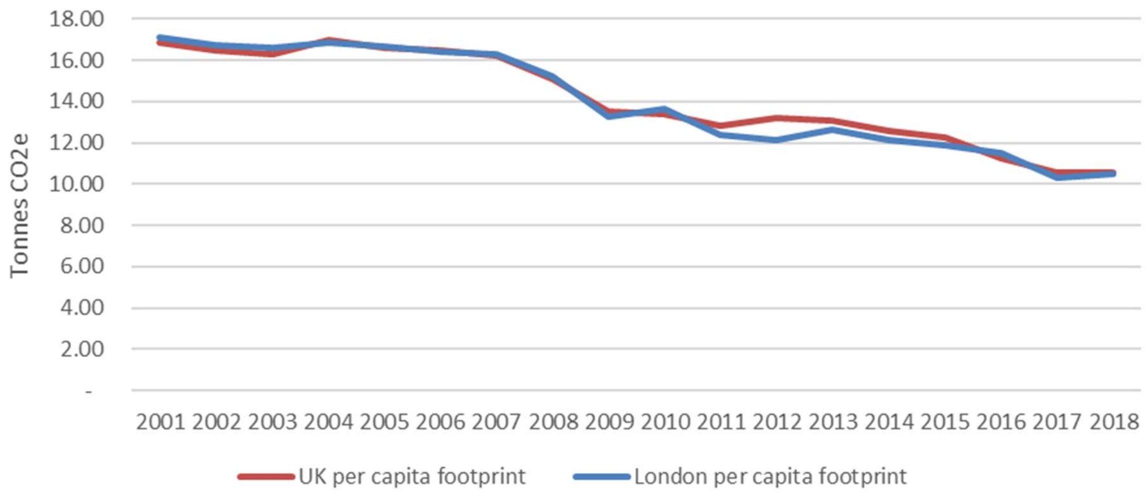

Figure 3: UK and London per capita footprints (2001-2018)

The per capita footprint for London is very similar to the average footprint for the UK and follows a similar trajectory.

The following analysis provides a high-level breakdown of the GHG footprint by consumption categories (Figure 3).

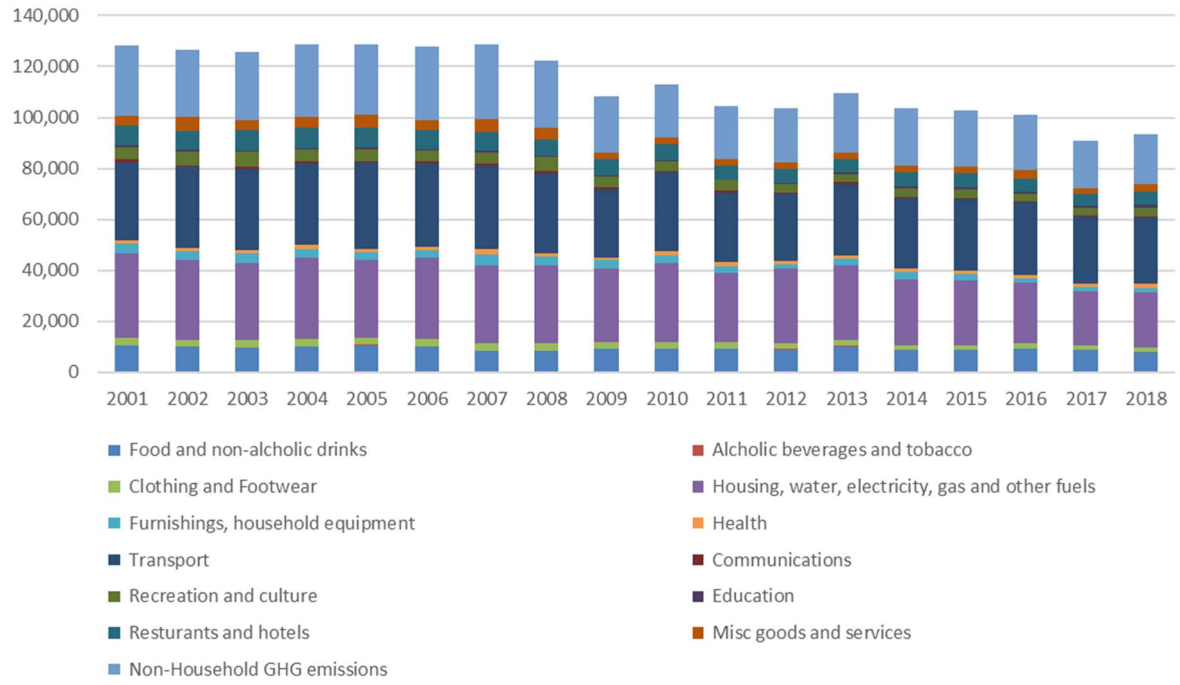

Figure 4: Household GHG footprint by COICOP category (2001-2018)

The three categories of food, housing and transport are responsible for 76% of the household footprint in London in 2018 (with households being responsible for 79% of the total footprint). The remaining 24% relate to goods and services (such as clothing, furnishings, recreation and culture, health and education) as shown in the chart above and detailed further in Section 4.2. The most notable decline has been the GHG emissions from housing, primarily due to the decarbonisation of the energy grid. Transport emissions have remained similar as has food. Goods and services have reduced.

4.2 Sectoral comparisons with the UK

This section compares the average per capita footprint of a London resident with the per capita footprint of the average UK resident for a number of different consumption items.

4.2.1 Food and non-alcoholic drinks

The food and non-alcoholic drinks footprint includes all spend on food consumed in the home. The average London resident has a lower-than-average impact for spending in this category but higher than average impact for spending on food and drink purchased outside the home, see Section 4.2.11 below.

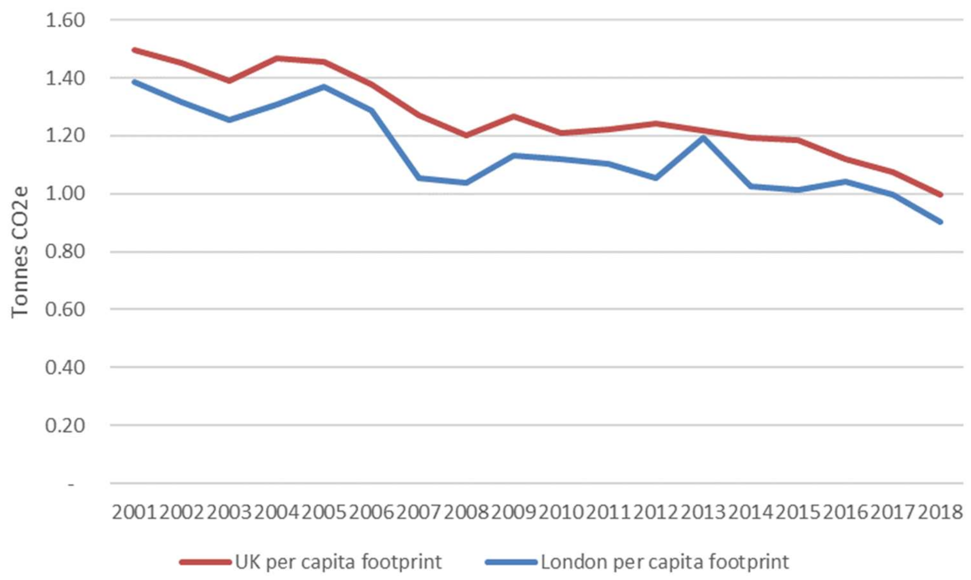

Figure 5: Food and non-alcoholic drinks footprint for London and UK (2001-2018)

4.2.2 Alcoholic beverages and tobacco

The alcoholic drinks footprint includes all spend on alcohol and tobacco consumed in the home. The average London resident has a lower-than-average impact for spending in this category.

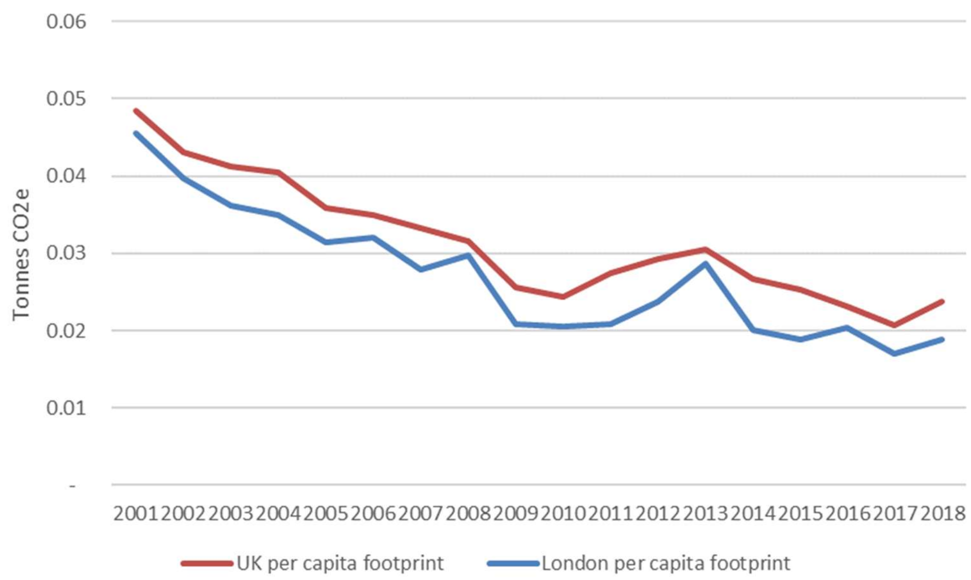

Figure 6: Alcoholic beverages and tobacco footprint for London and UK (2001-2018)

4.2.3 Clothing and footwear

The clothing and footwear footprint includes all spend on adult and children's clothes and shoes. The average London resident had a higher-than-average impact for spending in this category but recently the levels are quite similar.

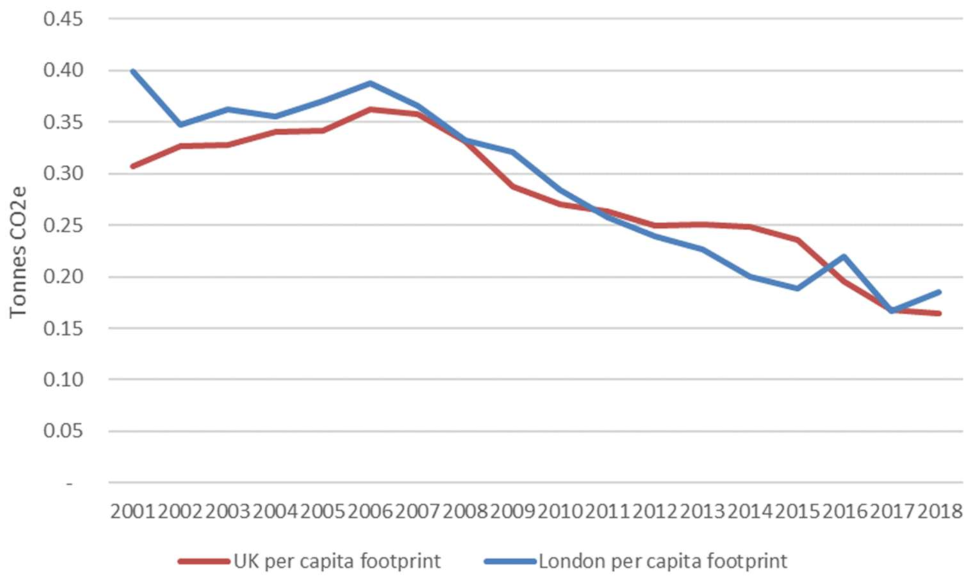

Figure 7: Clothing and footwear footprint for London and UK (2001-2018)

4.2.4 Housing, water, electricity, gas and other fuels

The housing, water, electricity, gas and other fuels footprint includes all spend on home repairs, heating, water and power. The average London resident has a very similar impact to the average UK resident.

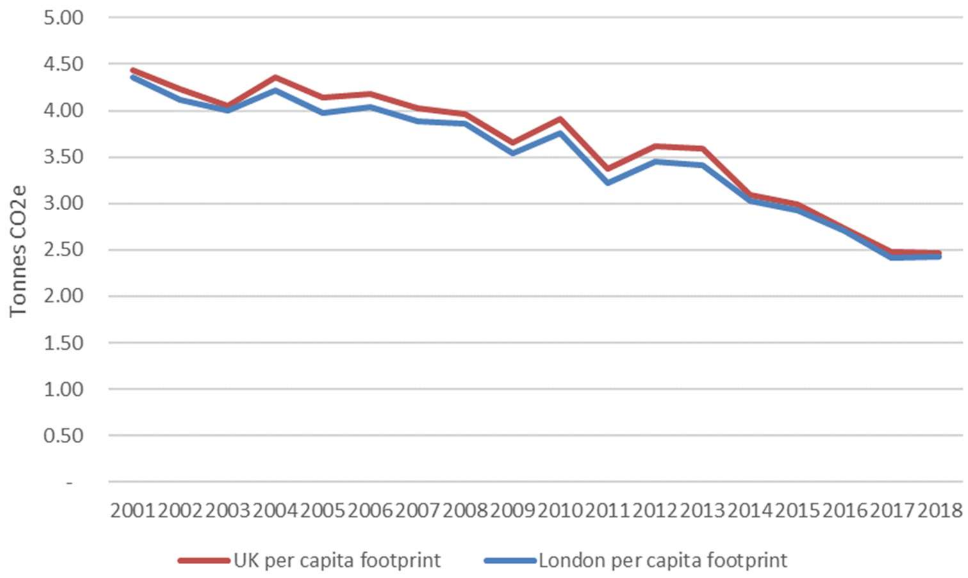

Figure 8: Housing, water, electricity, gas and other fuels footprint for London and UK (2001-2018)

4.2.5 Furnishings and household equipment

The furnishings and household equipment footprint includes all spend on furniture, carpets, kitchen equipment and kitchen appliances. The average London resident has a similar level of impact in this category to the rest of the UK.

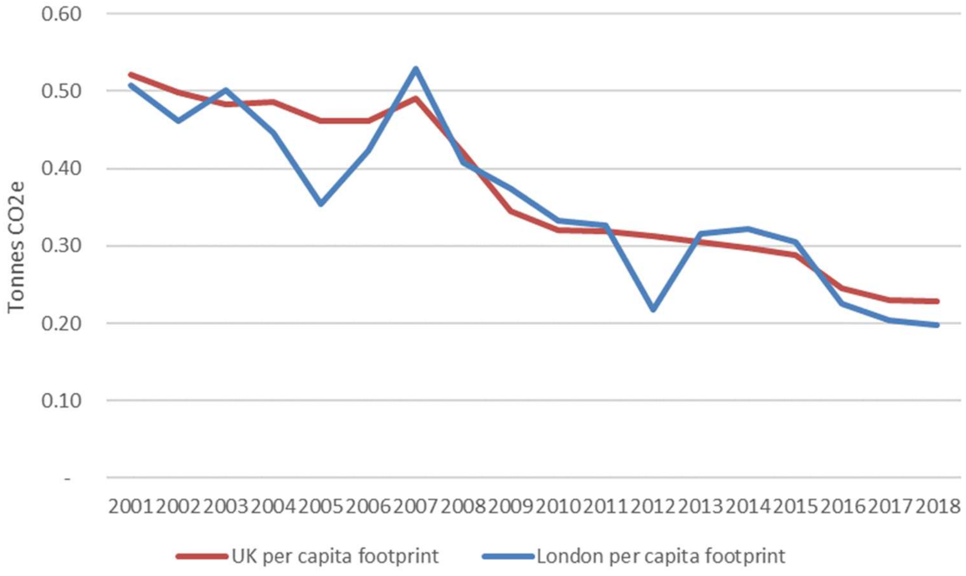

Figure 9: Furnishing and household equipment footprint for London and UK (2001-2018)

4.2.6 Health

The health footprint includes all spend on pharmaceutical products and hospital services. The average London resident has a similar level of impact in this category to the rest of the UK.

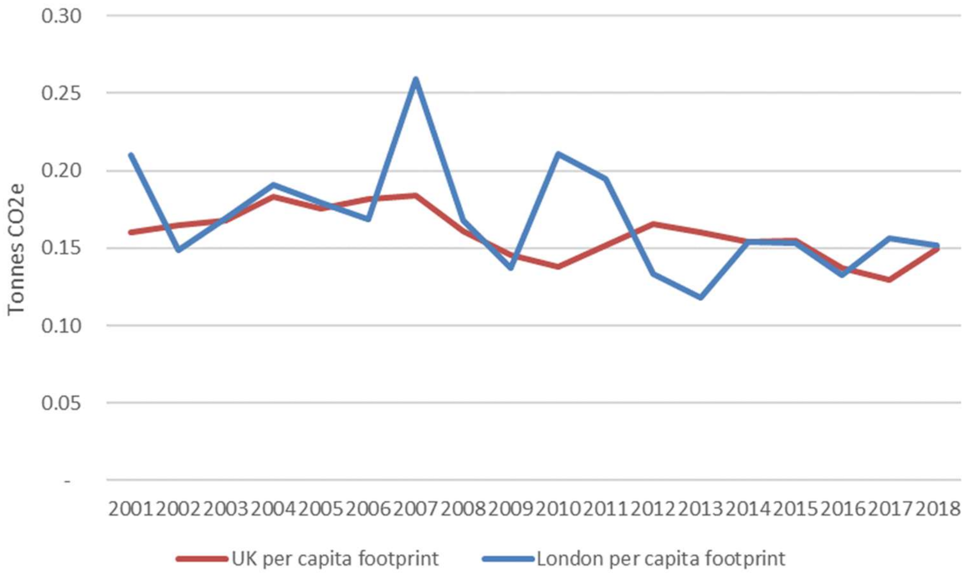

Figure 10: Health footprint for London and UK (2001-2018)

4.2.7 Transport

The transport footprint includes all spend on vehicles, operating private transport, public transport and air fares. The average London resident has a higher-than-average impact for spending in this category. This includes air travel, with Londoners spending more on international air travel than the average UK resident, which significantly increases per capita emissions.

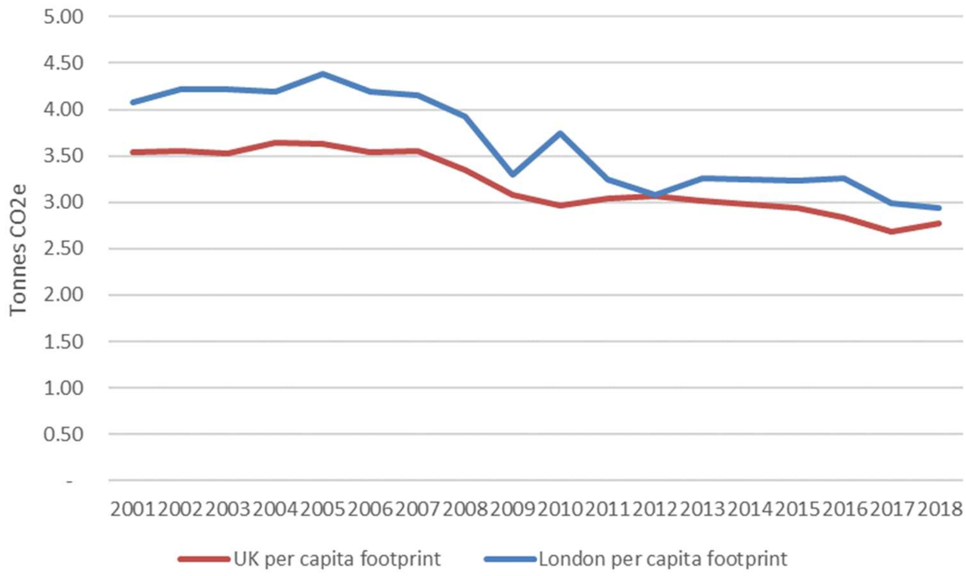

Figure 11: Transport footprint for London and UK (2001-2018)

4.2.8 Communication

The communication footprint includes all spend on post, mobile phones, internet and telephone services. The average London resident has a higher-than-average impact for spending in this category but recently the levels are very similar to the average for the UK.

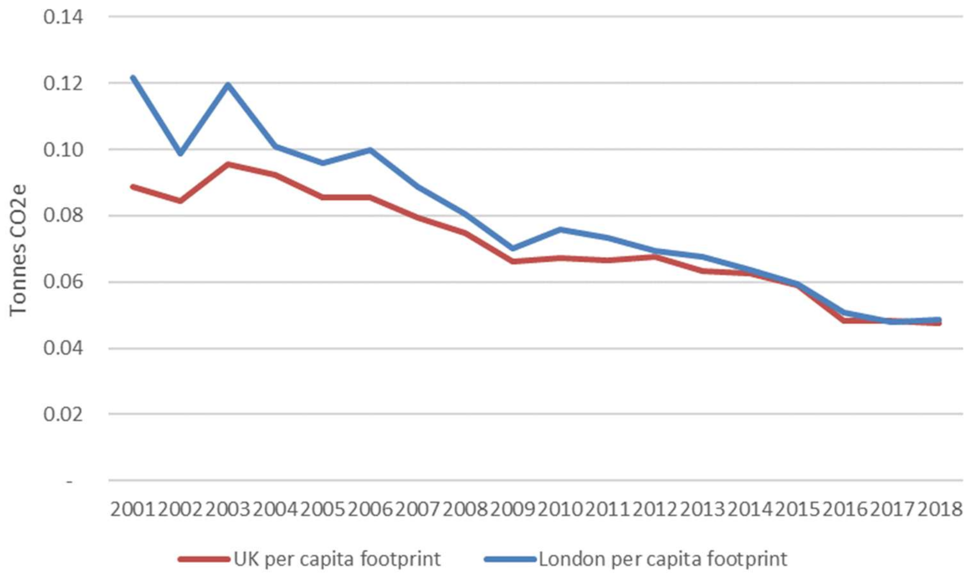

Figure 12: Communication footprint for London and UK (2001-2018)

4.2.9 Recreation and culture

The recreation and culture footprint includes a range of subsectors, including spend on books, games, sports, cinema, pets, boats, trailers, horses, caravans, TV, gardening and theatre. The average London resident has a lower-than-average impact for spending in this category. A sectoral breakdown at a UK level is not publicly available, therefore, it is difficult to determine what drives this difference.

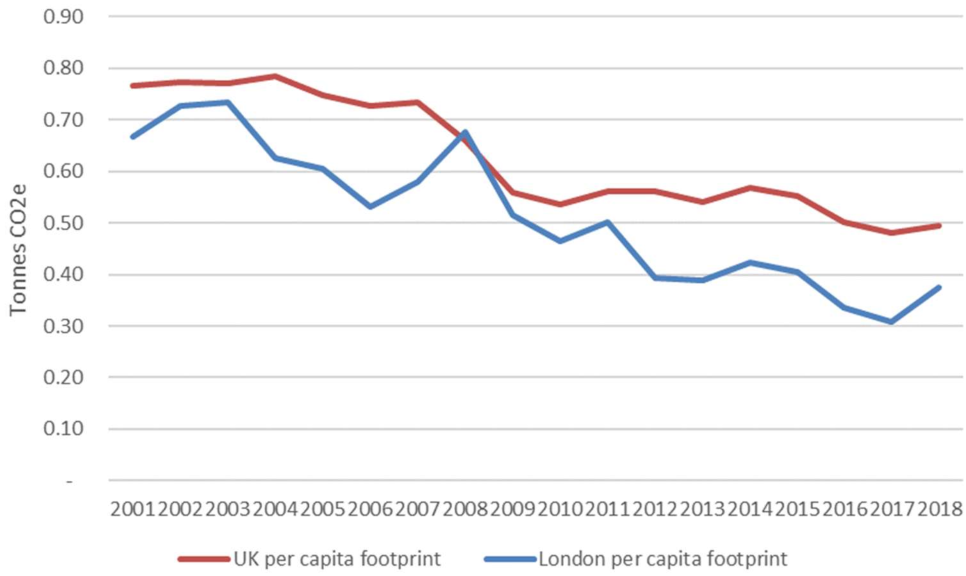

Figure 13: Recreation and culture footprint for London and UK (2001-2018)

4.2.10 Education

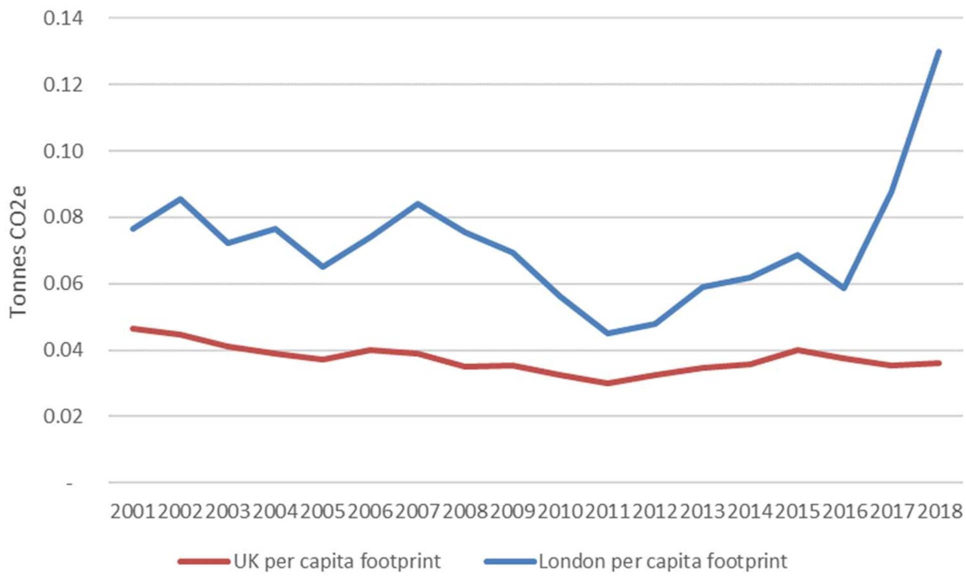

Figure 14: Education footprint for London and UK (2001-2018)

The education footprint is estimated from household spend on primary to university education. There is little or no footprint associated with state school education in this category because state education is paid for through household tax payments. The average London resident has a higher-than-average impact for spending this category. This may be due to a higher proportion of children going to private schools, a higher proportion of adults with university age children or higher a proportion of adults whose children do not get loans for university education. Figures for 2017 and 2018 are very high compared to previous years and the UK per capita footprint. If a single year was high, we would assume this was an anomaly in the LCFS and smooth the data but because it appears high for two years running we will leave this result and reassess in next year's update. Further years of data are needed to be sure if this is a trend or a blip. It is also worth noting that the emissions associated with Education represent just 1.2% of the total footprint.

4.2.11 Restaurants and hotels

The restaurants and hotels footprint includes all spend on catered food and drinks including canteens and pubs and accommodation services. The average London resident has a higher-than-average impact for spending in this category. As with the other sectors, without access to the emissions breakdown at a UK level, it is difficult to determine what drives this difference.

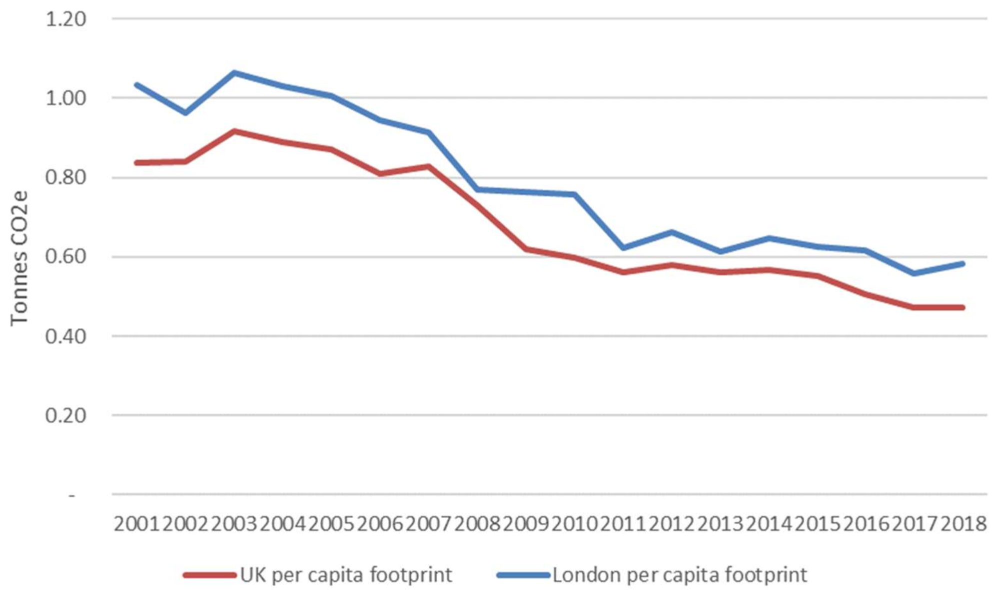

Figure 15: Restaurants and hotels footprint for London and UK (2001-2018)

4.2.12 Miscellaneous other services

The miscellaneous other services footprint includes all spend on hairdressing, babysitting, business and financial services. The average London resident has a similar impact to the rest of the UK.

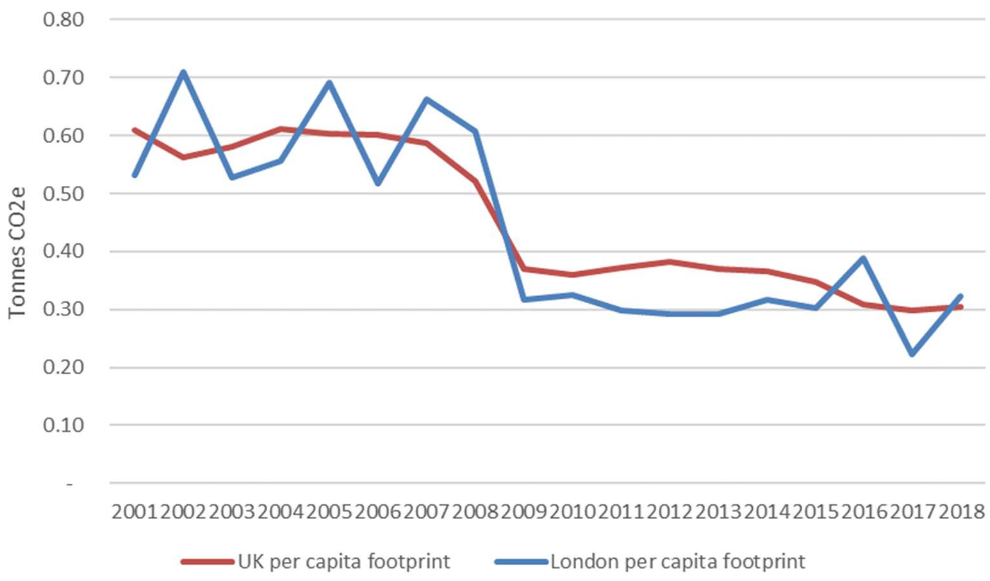

Figure 16: Miscellaneous other services footprint for London and UK (2001-2018)

4.3 Comparisons with previous years' estimates

The 2021 release of the consumption-based GHG footprint for London is lower than the previous time series for 2020 and 2019, and similar to the results released in 2018. This is due to some major revisions in the underlying UKMRIO database. The 2021 release of the **total UK** GHG emissions from consumption are around 76 Mt lower than the previous years' release due to methodological improvements. This is a decrease of around 9.9% and of course feeds through to the results for London, where we see a similar percentage reduction.

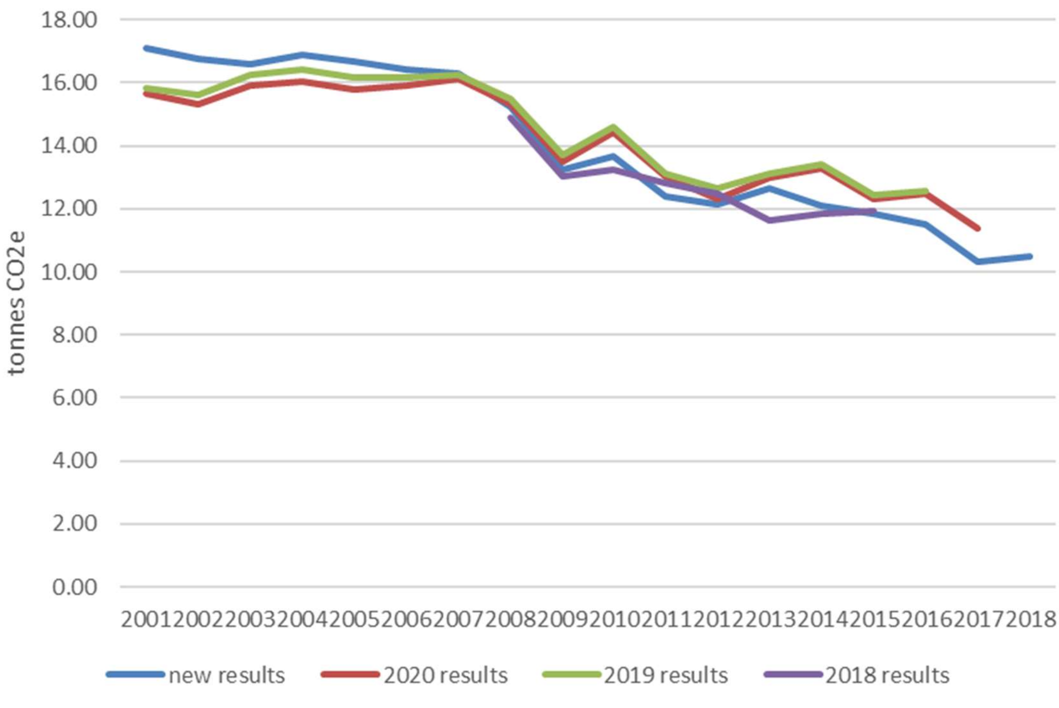

Figure 17: Comparing previous year's estimates in per capital footprints for London

In brief, the methodological improvements include:

- Change from using EXIOBASE 3.6 to EXIOBASE 3.8 for the trade data
- Sectoral detail in the supply and use tables increased to 112 from 106
- Inclusion of full suite of GHGs: CO_2, CH_4, N_2O, HFC, PFC, NF_3, SF_6
- Imported chemicals allocation fixed

In the following section we explain the effect **on the UK totals** from the methodological changes when comparing the 2020 release with the 2021 release. It is impractical to construct a 2021 model which changes one item at a time, so the exact effect cannot be quantified. However, it is possible to highlight which particular methodological change will have been the most responsible for observed differences in selected results.

4.3.1 Change from using EXIOBASE 3.6 EXIOBASE 3.8

In November 2020, the researchers behind the EXIOBASE MRIO databases launched EXIOBASE 3.8 to replace the other versions of EXIOBASE. EXIOBASE 3.8 is a complete update of the time series. EXIOBASE 3.8 now reports data from 1995-2019, whereas EXIOBASE 3.6 stopped at 2016. EXIOBASE 3.6 was modelled using actual supply and use tables in the years 1995-2011 but the data from 2012-2016 was projected. EXIOBASE 3.8 now replaces that initial projection but is using projected data from 2017-2019. Switching from v3.6 to v3.8 improves the UK consumption-based account estimates for the years 2012-2016 and allows better estimates for post 2016. In the 2020 release, we had to use the 2016 trade shares to represent years post 2016.

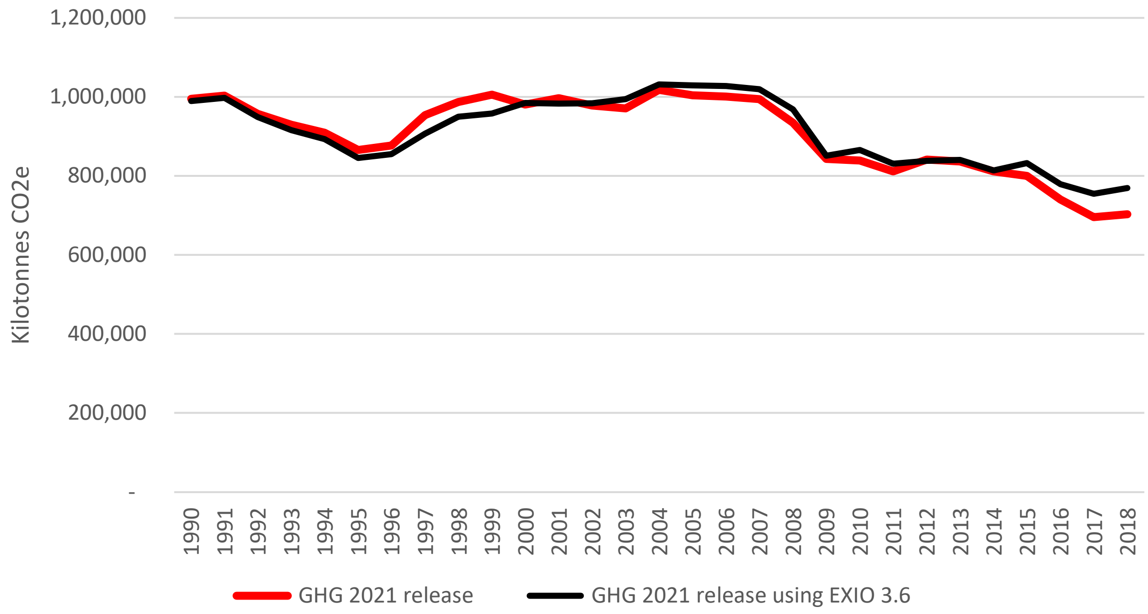

Figure 18: Comparing the Carbon Footprint produced by the UKMRIO using EXIOBASE 3 (red) and EXIOBASE 3.6 (black)

We were able to run the UKMRIO construction code using both EXIOBASE 3.6 and EXIOBASE 3.8 to demonstrate the difference in the UK's consumption-based account (Figure 18). The switch to the newer version of EXIOBASE results in an increase in the footprint from 1996-1999, effectively flattening the peak between 1999 and 2007. We also see a marked reduction in emissions from 2014-2018 (round 76 $MtCO_2e$ in 2018 ~ 9.9%). This partially explains the reduction in the London estimate in the 2021 release compared to the 2020 release.

4.3.2 Increased sectoral detail in the Supply and Use Tables

For the 2021 release of the UKMRIO, we were able to use UK SUT tables reported at 112 sectors rather than the 106 previously released (see Table 3 for description of changed sectors). This change resulted in quite substantial changes to the underlying Python code and it was impractical to construct a 2021 model using both the 106 and 112 sectors to be able to exactly quantify the effect of this change. However, it is possible to highlight how this change is responsible for observed differences in selected results.

Table 3: Changes in the 112 sectoral resolution compared to the 106 sectoral resolution

106 sectoral resolution	114 sectoral resolution
CPA_B06 & B07 Crude Petroleum and Natural Gas & Metal Ores	CPA_B06 Crude Petroleum and Natural Gas CPA_B07 Metal Ores
CPA_F41 & F42 & F43 Construction	CPA_F41 Buildings and construction works CPA_F42 Constructions and construction works for civil engineering CPA_F43 Specialised construction works
CPA_J59 & J60 Motion Picture, Video & TV Programme Production, Sound Recording & Music Publishing Activities & Programming and Broadcasting Activities	CPA_J59 Motion picture, video & TV programme production, sound recording & music publishing CPA_J60 Programming and broadcasting services
CPA_K65.1-2 & K65.3 Insurance, reinsurance and pension funding services, except compulsory social security	CPA_K651_2 Insurance, reinsurance CPA_653 Pension funding services
CPA_Q87 & Q88 Residential Care & Social Work Activities	CPA_Q87 Residential Care CPA_Q88 Social work services without accommodation

The most critical change is the splitting out of the mining of metal ore from the mining of crude petroleum and natural gas. With the 106-sector model we had to assign the CO_2e from both metal ore and fossil fuel extraction to a single mining sector. The UK sector 'Crude Petroleum and Natural Gas' has industrial emissions of around 18,000 $ktCO_2$, compared to just 7 $ktCO_2$ for the Ore sector, but their total economic output is similar. This means that the emissions per unit of output of petroleum and gas will be very large in comparison to the ore sector. When the sectors are combined, as in previous releases, the intensity of the combined sector is much too small for use with petroleum heavy goods because it is a similar volume of emissions divided by a larger monetary output. This means that for certain products, where petroleum is used in their manufacture (as an energy source or feedstock), their footprints will have previously been underestimated. Conversely for products which use significant ore in their manufacture, previous footprints will have been overestimated.

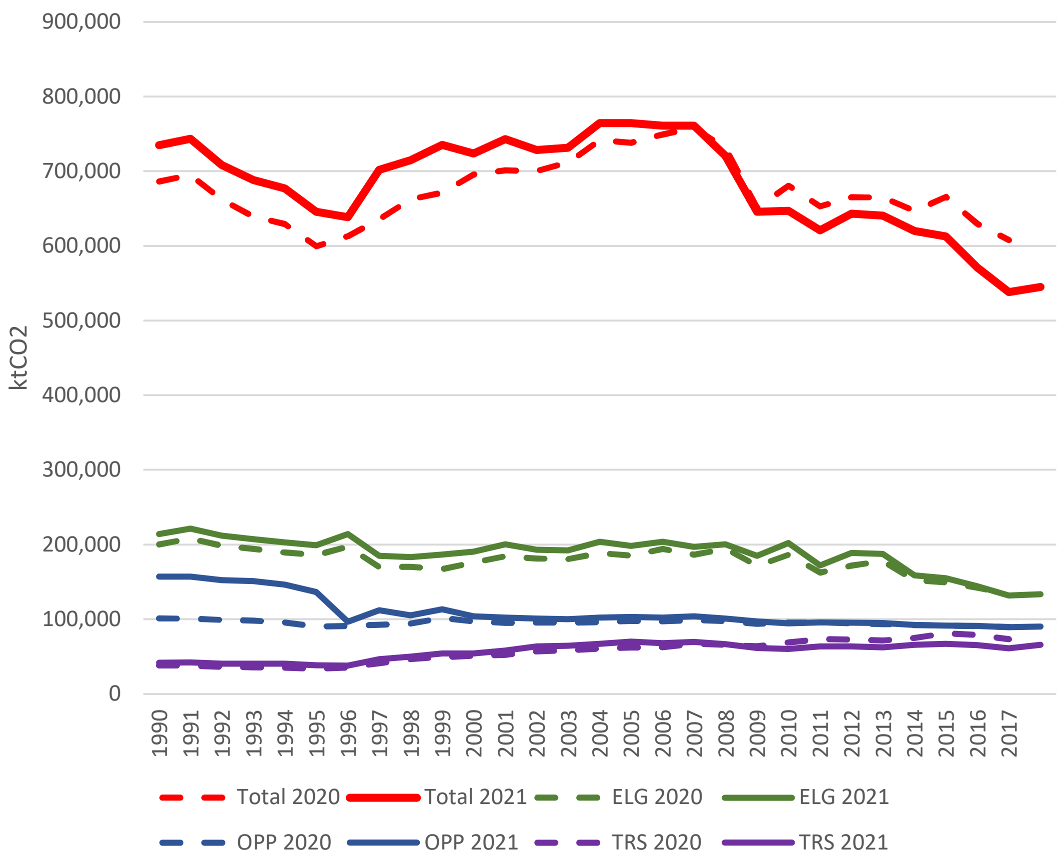

Figure 19: Comparing Total CO_2 emissions (red), Electricity, Gas and Other fuel (ELG – green), Operation of personal transport (OPP – blue) and Transport services (TRS – purple) for the 2021 and 2020 release

Figure 19 shows the difference in the consumption-based CO_2 account for the 2020 and 2021 release. We see that the 2021 release on average 7% higher from 1990 to 2006 and then the new release starts to estimate lower in later years as a result of the better trade data from 2012 onwards (explained in the previous section). This higher estimate can be explained by the differences in the fuel-intensive products *Electricity Gas and Other fuel* and *Operation of personal transport* for the earliest years and *Transport services* for the middle section. In this chart we compare CO_2 only so that the effect of including the additional GHGs is not contributing to the difference.

4.3.3 Increased basket of GHGs

In the 2021 release, we are able to include the full suite of GHGs: CO_2, CH_4, N_2O, HFC, PFC, NF_3, SF_6. In order to determine the effect of the increased basket of GHGs we need to remove the effect of the increased sectoral detail. To do this we take the 2021 GHG release and subtract the difference in the 2021 and 2020 CO_2 releases. This produces a rough estimate of what the 2021 release would have looked like without the sectoral change. There will be effects of other methodological changes in the data but these will be minimal at this stage.

Figure 20 shows that including the full suite of GHGs has a greater effect on the earlier years than the later years. This is because there have been great efforts to reduce GHGs meaning that a greater proportion of the footprint is CO_2 in more recent years.

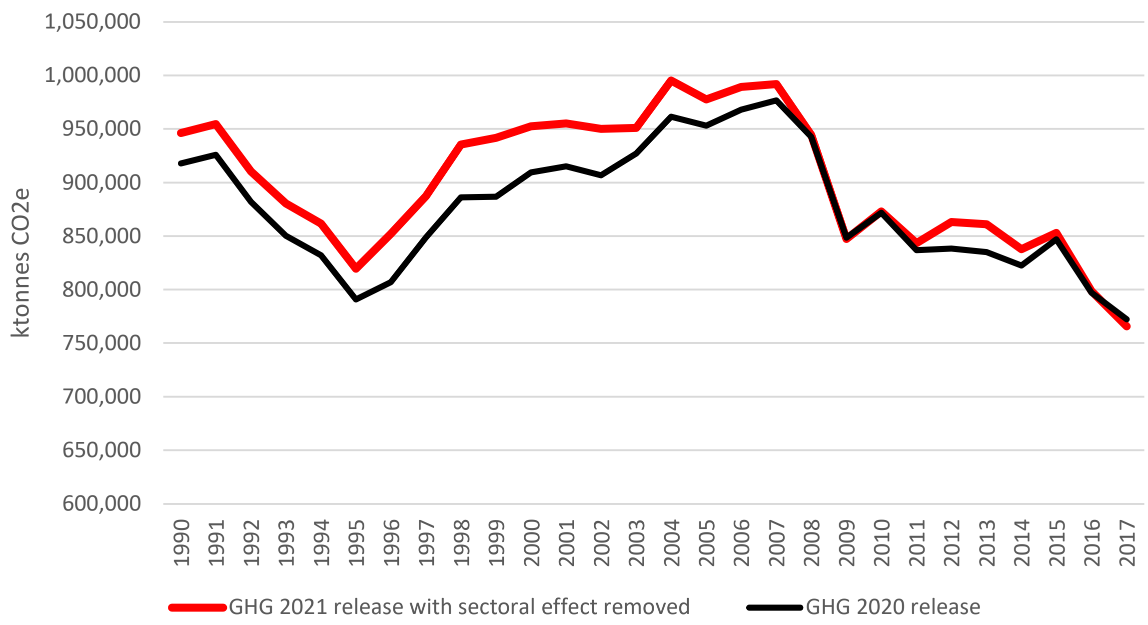

Figure 20: Comparing the effect of an increased basket of GHG

4.3.4 Imported chemicals adjustment

We discovered that the emissions associated with the non-UK chemical sectors were not being allocated correctly due to a labelling issue in the industrial classifications. The effect of correcting is most obviously seen in the footprint of *medical products, appliances and equipment (MED)*. This product sees a 10-30% increase in the emissions allocated between 1990 and 2010 (before the updated trade effect from EXIOBASE 3.8 kicks in in 2011). Correcting this sector increases the overall footprint by approximately 1%.

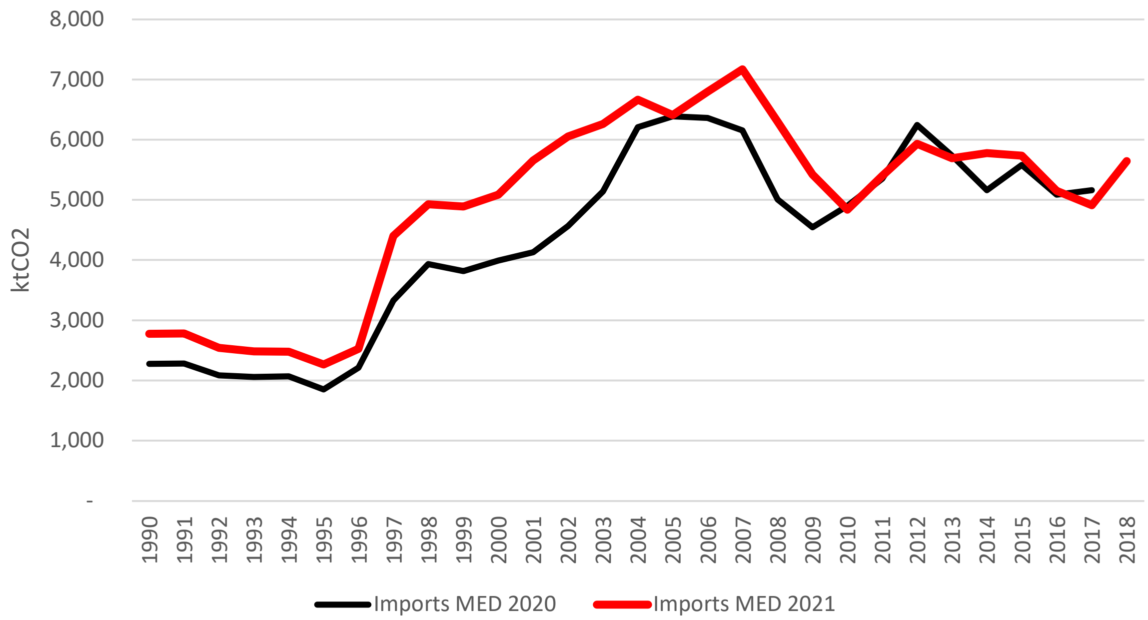

Figure 21: Comparing the effect of fixing the allocation of imported chemicals by focussing on medical products, appliances and equipment (MED)

5 Conclusions, recommendations and next steps

The University of Leeds has successfully developed a robust and replicable methodology to calculate the consumption-based GHG account for London. The methodology used ensures that the sum of the regions equals the UK CBA. Later in 2021, the household consumption-based accounts (HCBA) for the 32 London boroughs and the City of London will be published. The sum of these footprints will equal the household footprint of the GLA.

The data used to disaggregate the UK's CBA is free, open source and annually updated. Now that the methodology has been established, updating the dataset for 2019 should be a relatively straight forward process. The UKMRIO database will be updated in early 2022 and will be capable of reporting the UK CBA for 1990-2019. This data will be published in Spring 2022. Once this data is published, the 2019 GLA results can be processed and if requested, HCBA for the London boroughs and the City of London.

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 2001-2018 will be re-estimated in 2022 and may 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.

University of Leeds will continue to improve the underlying data. There have been substantial improvements in relation to previous estimates. Our suggestions for further analysis are:

- Capital and infrastructure – National averages are applied and a detailed assessment of the embodied emissions of national infrastructure would help identify additional mitigation options.
- Government – instead of proportioning the national average, an additional study could consider the GHG emissions of the GLA.
- Alternatively, we can simply report the consumption-based account for households only. This is the option that London Councils have opted for in their household consumption-based account of the 32 London boroughs and the City of London.