GREATER LONDON AUTHORITY

London's Food Sector Greenhouse Gas Emissions

FINAL REPORT

A Report for the Greater London Authority

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Executive summary

This report builds on the Mayor's 2007 Climate Change Action Plan and the London Food Strategy (2006) by quantifying the contribution of London's food sector to the capital's greenhouse gas (GHG) emissions.

The main body of the report comprises an analysis of the food production-consumption chain, summarised in Table 1, below. The findings are based on internally consistent datasets with explicit assumptions, which are detailed in Appendix 1. They provide a robust basis on which to identify priority actions to address the environmental impact of London's food sector, and will inform the Climate Change Mitigation and Energy Strategy, due for publication in 2009.

The final section of the report complements the main quantitative analysis by presenting a range of qualitative and quantitative evidence on a series of London-specific issues that influence the city's relationship with food and, by extension, food-related emissions.

Table 1 Total GHG associated with London's food system (1,000 tonnes CO_2eq) 2005

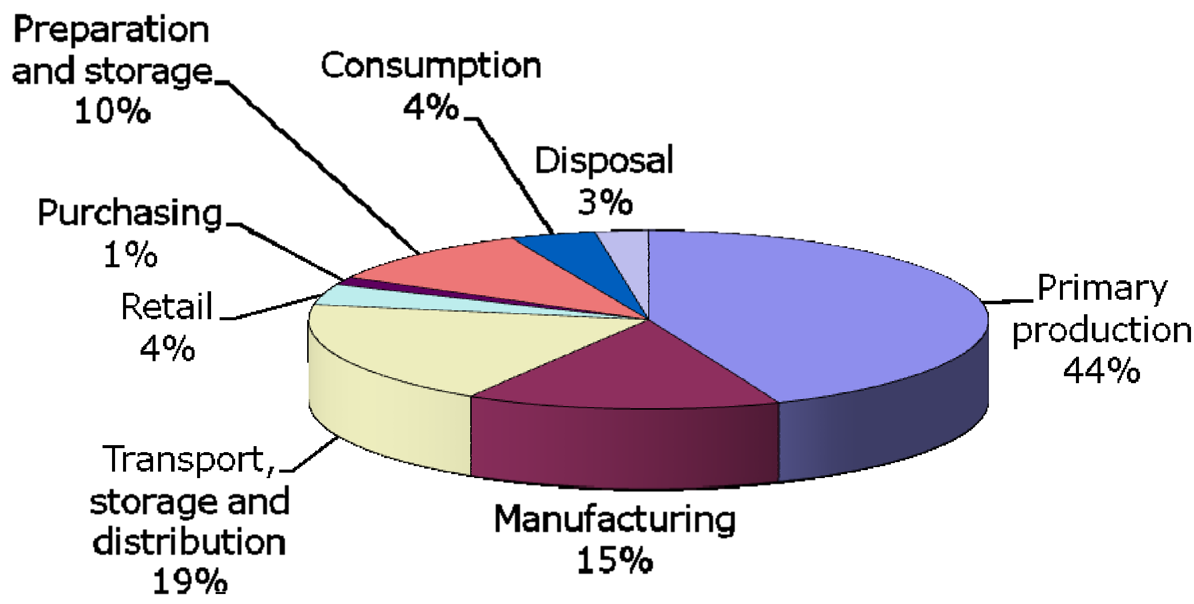
	CO_2 Carbon dioxide	CH_4 Methane	N_2O Nitrous oxide	HFC Hydrofluoro carbons	PFC Perfluoranated carbons	SF_6 Sulphur hexafluoride	Total
Primary production	1,071	2,882	4,238	3	-	-	8,195
Manufacturing	2,748	28	21	4	-	2	2,803
Transport, storage, distribution	3,482	7	45	21	-	-	3,555
Retail	526	5	10	164	-	-	706
Purchasing	265	-	-	-	-	-	265
Preparation and storage	1,964	-	-	-	-	-	1,964
Eating and consumption	723	10	6	17	-	1	760
Disposal	19	448	-	-	-	-	469
Total	**10,800**	**3,380**	**4,323**	**209**	**-**	**3**	**18,716**

Source: Brook Lyndhurst. Totals may not add up due to rounding

The Climate Change Action Plan estimates that London is responsible for some 44 million tonnes of carbon dioxide emissions per year. This figure and the figures in Table 1, above, are not strictly comparable, since the Climate Change Action Plan measures only CO_2 emissions, and only includes emissions produced within the administrative boundary of London. However, comparison of these figures gives some idea of the scale of the food sector's contribution.

Chart 1 shows the large contribution of primary production (mainly agriculture) to the environmental impact of London's food sector. In fact, the production and processing of food accounts for more than two thirds of total emissions, and transport accounts for nearly one fifth. At the other end of the food chain, one tenth of total emissions arise from storing and cooking food at home.

CHART 1 Total GHG emissions by stage of the London food chain

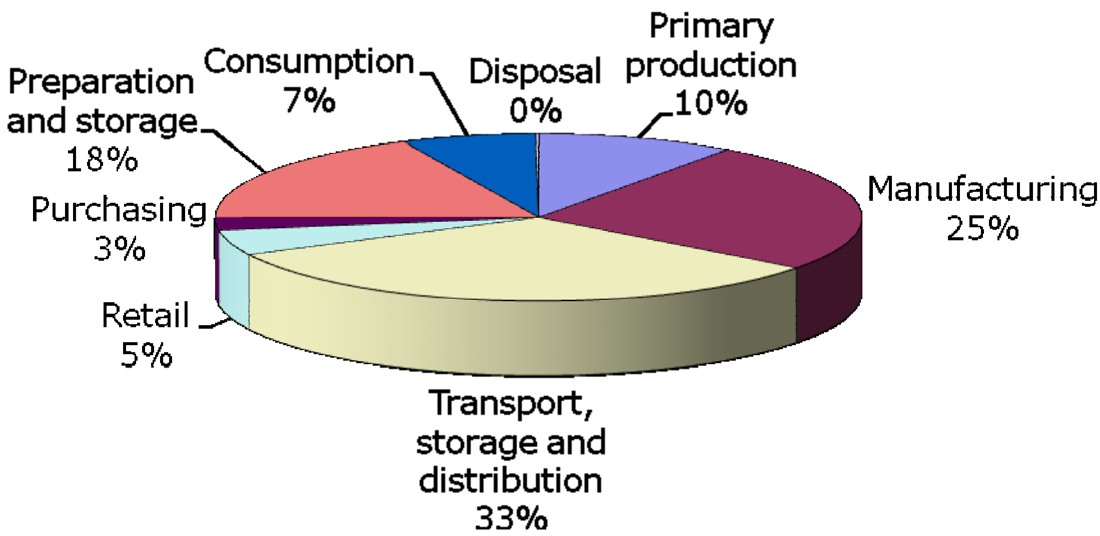


Source: Brook Lyndhurst

This analysis includes the full basket of greenhouse gases covered by the Kyoto Protocol. This is an important perspective, since some greenhouse gases have a greater effect on climate change than carbon dioxide (CO_2); for example, methane has 21 times the effect of CO_2 over the course of

100 years, and hydrofluorocarbons (often used as a refrigerant) can be up to 11,700 times more powerful. Chart 2 (below) shows how the picture changes when only CO_2 is taken into account.

CHART 2 Total CO_2 emissions by stage of the London food chain



Source: Brook Lyndhurst

Chart 2 shows that the primary production stage accounts for a much smaller proportion of emissions when only CO_2 is considered; in fact, emissions from home preparation and storage of food are almost double those from primary production. The largest contributor is the Transport, storage & distribution stage, which is responsible for one third of total food-related CO_2 emissions. It is interesting to note that the CO_2 contribution of the Disposal stage is not large enough to register in this CO_2 account: the vast majority of emissions are made up of other greenhouse gases.

The analysis in this report takes a 'responsibility' approach to London's food-related emissions: it accounts for emissions that result from London's food consumption, regardless of where they occur. Charts 3 and 4 (overleaf) give an approximate idea of the emissions arising from the food chain stages that are mainly inside London and those that are mainly outside.

CHART 3 GHG emissions arising mainly outside London

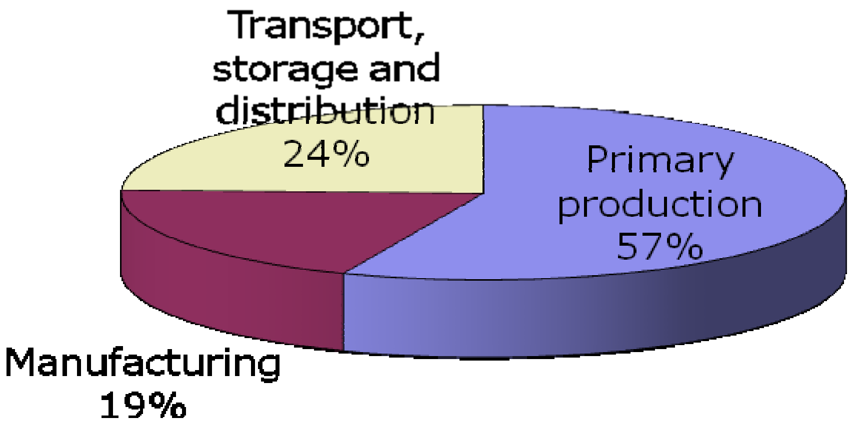
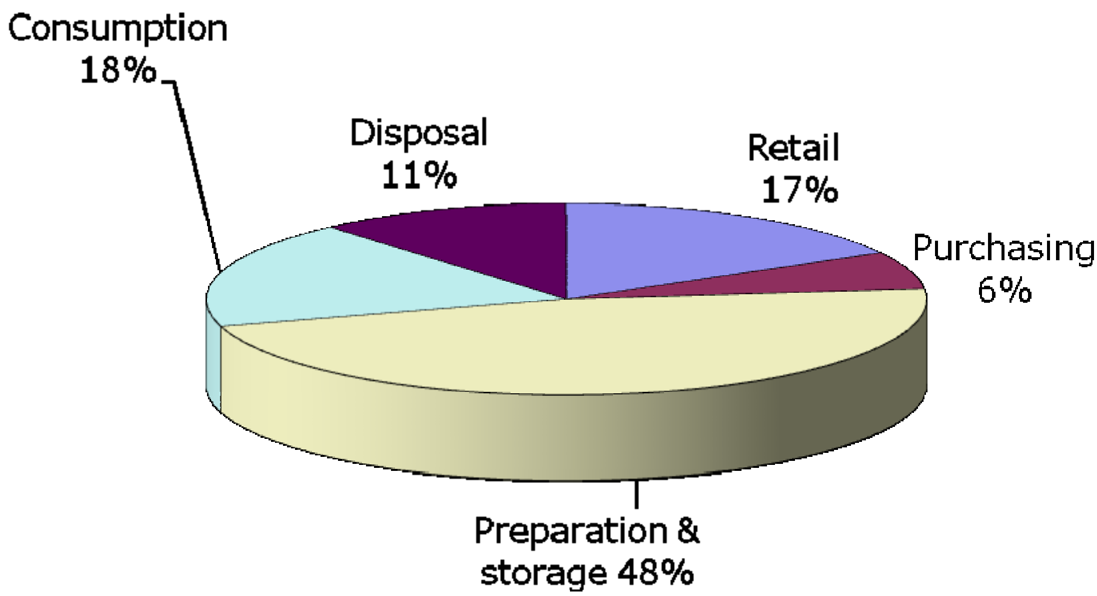


CHART 4 GHG emissions arising mainly inside London



Source: Brook Lyndhurst

Chart 3 highlights how the environmental impact of London's food consumption stretches right back to the very first stages of food production: primary production again stands out as the largest contributor to the GHG emissions that arise mainly outside London. Chart 4 shows that, within London, the retail and "consumption" (hospitality) sectors contribute roughly equal quantities of GHGs, but both are dwarfed by the GHGs that result from home storage and preparation of food.

As well as these detailed quantitative results, the report covers a number of issues that cut across the food chain and which may provide a footing for influencing food-related GHGs. The final section of the report discusses issues that include:

- public sector food procurement;
- London's unique retail and hospitality structures;
- 'alternative' food sources, such as farmers' markets and allotments;
- the London 2012 Olympic and Paralympic Games; and
- London's small and medium food enterprises.

In order to provide some basis upon which to prioritise actions, these issues are scaled within the context of the main quantitative findings. Public procurement and the retail and hospitality sectors are identified as having a particularly large part to play in the GHG emissions arising from London's food.

The analysis shows that London's food spans all of the major sectors identified in the Climate Change Action Plan and makes a significant contribution to the capital's greenhouse gas emissions. The evidence presented in this report provides a deeper understanding of the nature and scale of that contribution. It takes into account the unique characteristics, pressures and opportunities presented by London's food sector, and provides a firm foundation from which to identify ways to reduce the climate change impacts of London's food.

1 Introduction

In January 2008, Brook Lyndhurst was commissioned by the Greater London Authority to conduct a research project aimed at quantifying the greenhouse gas (GHG) emissions associated with the food sector in London. The focus of this research is on the impact of food consumption on GHG emissions and includes emissions produced both inside and outside London boundaries as a result of Londoners' food consumption.

The research, conducted over a two month period, is structured around the 'food architecture' that underpins the Mayor's Food Strategy for London (2006). Estimates of GHG emissions generated using the best available data are provided for each stage of the food chain.

This research provides a rigorous estimate of London's food sector's contribution to GHG emissions. (A complete quantification would require very significant time and resources – for example, Walkers Crisps took nearly two years to quantify the carbon emissions associated with a typical packet of Walkers crisps, and this represents just a single food type.) The approach adopted here was to produce rigorous quantitative estimates for each stage of the food chain complemented by discussion around factors specific to London that have an impact on GHG emissions. Qualitative evidence was also gathered on areas that are not explicitly considered in the quantitative analysis with a view to highlighting the scale of some issues – such as food served in hospitals or schools – and the initiatives that are currently under way that could help reduce emissions.

The report starts by setting out the context for the study and the overall approach taken. This is also where the rationale behind the chosen methodology is explained and where London-specific issues and their likely impact on GHG emissions associated with the food sector are exposed.

Section 3 presents the main body of the research findings, a quantitative analysis of the GHGs arising from each stage of London's food production-consumption chain. The calculations for each stage are underpinned by publicly available, reliable data from a variety of sources, and local data is also used where possible to highlight the uniqueness of London and the particular challenges and opportunities that its food system presents. The Appendix contains full details of the methodology and data sources.

Section 4 presents a range of issues that have strong links with the food sector but which have not been formally quantified, such as public procurement, food distribution patterns and community initiatives. The objective here is to indicate the potential scale of each issue on overall GHG emissions through qualitative evidence with a view to complementing the quantitative analysis in Section 3.

2. Context & Approach

This section sets out the context for this study before looking at the approach taken. A significant amount of work has been involved in choosing an appropriate methodology for calculating GHG emissions associated with the food sector in London. The priorities were to ensure the methodology chosen would make use of the best available data, be internally consistent and avoid double counting emissions. Consideration was also given to setting appropriate boundaries and identifying the different ways in which Londoners' relationship with food affects GHG emissions.

This section therefore begins by setting out the policy and technical context for the work (Section 2.1), then outlines the overall research approach (2.2). Section 2.3 discusses a number of structural issues that affect the relationship between London and its food-related GHG emissions and, finally, Section 2.4 considers some of the issues arising from particular food choices.

2.1 Context

This study, which seeks to clarify the scale of greenhouse gas (GHG) emissions associated with the food sector in London, is timely. One of the five strategic objectives of the Mayor's London Food Strategy, launched in 2006, is to reduce the negative environmental impact of London's food system. The Mayor's Climate Change Action Plan (2007) also sets a path to tackle the climate change challenge and to deliver London's CO_2 targets and it is worth noting that London's complex food system spans all the key sectors identified by the Plan (domestic, commercial, energy supply and transport). The GLA Act 2007 inserted a new responsibility into the GLA Act 1999 (section 361B) requiring the Mayor to develop a Climate Change Mitigation and Energy Strategy that covers GHGs. In this context, a better understanding of the scale of the issue will help focus discussions on priority areas.

It is important to note, however, that GHG emissions are only one of many aspects of the sustainability of the food system. Different sustainability considerations may sometimes conflict; for example, a recent study[1] found no clear evidence that an organic 'shopping trolley'

[1] Manchester Business School for Defra (2006) *Environmental Impacts of Food Production and Consumption*

had a lower overall environmental impact than a conventional one; or that local food was necessarily the better choice (in terms of overall environmental impact) in all cases. Despite their wider benefits, there is no conclusive evidence that either organic or local food generate lower GHG emissions overall than the alternatives. It is therefore important that findings from this work are considered within the context of broader measures of sustainability, such as food security, the potential wider benefits of organic production, supporting local economies and regeneration.

Measuring GHGs associated with the food sector in London is more complex than it might first appear. This is because:

- Methodologies to measure GHGs in different sectors of the economy are still in their infancy and, as a result, existing estimates of the environmental impact of food vary widely. The Department for Environment, Food and Rural Affairs (Defra) calculates, for example, that the food chain is responsible for 17% of the UK's greenhouse gas emissions, while the EC estimates that 31% of all EU consumption emissions are food related[2].
- There is little information available about the environmental impact of different types of food, and there is usually little consistency between the methodologies used to derive GHG emissions associated with particular products.
- The boundaries of the food system must be carefully defined; it is important to decide, for example, whether the analysis be confined to direct activities of the agricultural sector, or whether to include inputs into that sector (e.g. tractor manufacturing).
- GHG emissions associated with food *production* differ from those associated with food *consumption.* This difference is particularly acute in London where there is relatively little food production within the city boundary. For example, there is relatively little agriculture within the London boundary, but Londoners consume large amounts of primary produce from all over the world. Hence London's agricultural *consumption* emissions are likely to be much higher than its agricultural *production* emissions.

[2] European Commission (2006). *Environmental Impact of Products (EIPRO): Analysis of the life cycle environmental impacts related to the final consumption of the EU-25*. http://ec.europa.eu/environment/ipp/pdf/eipro_report.pdf

The next section looks in more detail at how the methodology deals with these considerations.

2.2 Approach

2.2.1 Defining boundaries

London's unique size and economic structure mean that the city exerts strong economic and environmental influence beyond its boundaries. London's food system is no exception to this: every day, millions of Londoners, tourists, visitors and commuters make food choices that have an environmental impact throughout the entire food chain - in London, throughout the UK and in the rest of the world.

The first step in estimating the environmental impact of London's food sector is to define the food sector and delineate the boundaries of London's sphere of responsibility. GHG emissions associated with London's food occur at all stages of the supply chain. There are GHG emissions associated with:

- The use of fertilisers, the breeding of livestock and fuel use at the primary production stage;
- Energy and fuel use related to manufacturing and processing food;
- Fuel and energy used to transport, store and distribute food;
- Fuel use associated with transporting food from producers to processors, wholesalers and retailers;
- Energy used by retailers;
- Fuel use related to customers going to the shops to buy food;
- Energy used to prepare food in the home;
- Energy use associated with preparing food in restaurants, hotels and cafes; and
- Fuel use related to moving waste to landfill and the anaerobic decomposition of waste.

Drawing on the architecture developed in the Mayor's Food Strategy, we have therefore defined a ***food production-consumption chain*** made up of eight stages:

Table 2.1 The Food Chain	
Stage 1	Primary Production
Stage 2	Manufacturing
Stage 3	Transport, storage and distribution
Stage 4	Retail
Stage 5	Purchasing
Stage 6	Preparation and storage
Stage 7	Consumption (mostly GHG emissions from eating out)
Stage 8	Disposal

For the purposes of this study, it is assumed that ***London is responsible for all emissions associated with the food it consumes, regardless of where they arise***.

2.2.2 Greenhouse Gas Emissions

This study considers the full basket of greenhouse gases covered by the Kyoto Protocol (see Table 2.2) and calculates the GHG emissions associated with each stage of the food chain for the base year 2005.

Table 2.2 Greenhouse Gases[3]		
Gas		Global Warming Potential (GWP 100)
CO_2	Carbon dioxide	1
CH_4	Methane	21
N_2O	Nitrous oxide	310
SF_6	Sulphur hexafluoride	23,900
HFCs	Hydrofluorocarbons	140-11,700
PFCs	Perfluoranated carbons	6,500-9,200
Source: Intergovernmental Panel on Climate Change[4]		

Global warming potential (GWP100) is a measure of the environmental impact of a greenhouse gas relative to the effect of CO_2 over the course of 100 years. The aggregated results of all the GHGs are expressed in CO_2

[3] These figures are from the Intergovernmental Panel on Climate Change (IPCC)'s Second Assessment Report, 1995. Although updated figures are available from the Third Assessment Report (2001), it was agreed internationally that the 1995 figures will be used during the first commitment period under the Kyoto protocol (2008-2012). The UK Environmental Accounts are based on these figures.

[4] IPCC (1996). *Climate Change 1995. The Science of Climate Change*. Contribution of Working Group I to the Second Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press 1996).

equivalent (CO_2eq). To get an accurate picture of the impact of London's food system, it is essential to consider the full range of pollutants; see Page 18 of this report for details of how the picture changes if we only consider carbon dioxide.

2.2.3 Methodology

The findings of this report are based on internally consistent datasets with explicit assumptions. The starting point for most of the stages in the food chain is the UK Environmental Accounts[5], which break down GHG emissions by 96 industrial sectors. The Environmental Accounts give a reliable basis on which to calculate London's food sector emissions and, since they are a satellite account of the National Accounts, they can be used in conjunction with standard national and regional economic measures, such as Gross Value Added (GVA).

GHG emissions in the Environmental Accounts are emissions associated with production rather than consumption. As a result, the first step for the production stages of the food chain (Primary Production and Manufacturing) was to convert UK production emissions into consumption emissions by adding imports and excluding exports, before apportioning emissions to London. The full methodology is detailed in Appendix 1.

Example 1: Food manufacturing

The manufacturing of the food consumed in London takes place mostly outside of the capital, so the analysis begins with UK Environmental Accounts data on the GHGs that result from UK food manufacturing ('production figures'). However, not everything produced in the UK is for UK consumption: to arrive at the emissions associated with UK *consumption* of manufactured food, we must exclude exports (since they are not consumed here) and include imports. This means taking into account all emissions produced overseas that arise from our food consumption. In this respect, this analysis is in line with the UK Environmental Accounting methodology, rather than the Kyoto Protocol. The latter only accounts for emissions produced within a territory and so excludes overseas emissions from a country's account.

For the Retail, Consumption (Hospitality) and Disposal stages, GHG emissions associated with that sector directly reflect use (or consumption) of that service.

[5] ONS (2006). Environmental Accounts 2005

Example 2: Food retail

UK GHG emissions associated with the food retail sector reflect the sector's energy consumption as well as emissions arising from the distribution activities of retailers' vehicle fleets. Gross Value Added (GVA) data was used to calculate the proportion of the retail sector that is food related, and to allocate those emissions to London.

A bottom-up approach was used for the Purchasing and Preparation and Storage stages since local data is available, which gives a more accurate picture of the environmental impact of these activities.

Example 3: Food purchasing

Emissions arising from Purchasing occur as a result of consumer travel to buy food. The Environmental Accounts do not cover domestic transport, so various other sources, including Department for Transport data on personal travel, available at the national and regional levels, were used to determine trip length for food shopping versus shopping in general. This, combined with local data on average number of food shopping trips, gives London's food shopping miles, which were then converted into GHG emissions.

In summary, the benefits of using this methodology are twofold:

- By using Environmental Accounts where possible, the data produced is not only internally consistent but the risk of double counting emissions across sectors is minimised;
- The bottom-up approach to the later stages of the food chain complements the top-down analysis by using the best available local and regional data for the stages not covered by the Environmental Accounts. Data sources include London's personal travel data from the Department for Transport and London's domestic energy consumption from the Department for Business, Enterprise and Regulatory Reform.

2.3 Structural issues

Consumer preferences in general, and food choices in particular, are a function of a complex set of demographic, economic and institutional conditions. London is the most ethnically diverse region of the UK and has a demographic and socio-economic profile significantly different from the UK average. These differences are likely to have an impact on London's food system and, by extension, on the scale and pattern of its GHG emissions.

However, it would be very difficult to measure accurately the diverse influences of London's particular socio-demographic structure on the food chain, not least because this influence is not likely to be clear cut. Whilst the food choices by a particular socio-demographic group may generate relatively more food miles, for example, this group may consume less processed food, thereby generating fewer GHG emissions than average in the manufacturing stage of the food chain. The result could be that higher emissions in one stage of the food chain are cancelled out by lower emissions in another.

The purpose of this section is to illustrate how London's specific socio-demographic profile may interact with the food chain – and, therefore, GHG emissions - rather than to provide a comprehensive account of these various influences.

2.3.1 Demographic profile

The London population is relatively younger than the Great Britain average. People aged 20-29 account for 17% of the population in London compared to 13% in Great Britain. This is also the age group which spends 42% of their food and drink budget on eating out compared to a UK average of 32%. This would partly account for the relatively large share of the restaurants and catering sector in London – although tourism is another obvious driver in that sector.

Table 2.3 Population estimates 2006

	Great Britain		London	
	000's	%	000's	%
Under 20	14,249	24	1,801	24
20-29	7,641	13	1,270	17
30-49	16,960	29	2,502	33
50 and over	19,996	34	1,938	26
Total	**58,846**	**100**	**7,512**	**100**

Source: NOMIS

In terms of GHG emissions, it is possible that the relatively high number of young people with a greater propensity to eat out may contribute to higher GHG emissions in the Consumption stage and, by extension, to lower emissions in the Preparation and Storage stage. It may even be possible that economies of scale resulting from a large number of people eating out may result in the reductions in GHG emissions in the Preparation and Storage stage exceeding the increase in the GHG emissions in the Eating and Consumption stage. There is, however, little by way of evidence on either side.

2.3.2 Ethnic profile

London is a city of great ethnic diversity:

- Just 59.8% of London's population is White-British, compared to 88.2% in the UK as whole;
- The 2001 Census showed that there were almost 2 million London residents who were born outside of the UK, representing 160 different countries;
- London's population is 12% Asian or Asian British and 11% Black or Black British;
- The fastest growing population group is the Chinese group (24% increase between 2001 and 2004).

This diversity contributes to London's strong hospitality and speciality food retail sector, and affects the kinds of food Londoners eat. According to the Family Food Survey[6], certain food purchases and eating out patterns can be linked to the ethnic origin of the household. For example, in the UK:

- Households where the household reference person (HRP) was White consumed more dairy products than other groups, but fewer eggs;
- Black households consumed most fish and fruit;
- White households consumed almost twice as many potatoes per person than Asian households;
- Asian households consumed the least alcohol; and
- Chinese and 'others' consumed most vegetables.

This indicates that ethnicity is a factor that is likely to shape London's food GHG profile. However, estimating the GHG implications of these patterns is difficult, since there is not yet a standard methodology for calculating the emissions associated with different food types.

[6] Defra (2007). *Family Food in 2005 – 06*

2.3.3 Socio-Economic profile

The income structure in London is somewhat polarised: on one hand, Londoners earn significantly more than the UK average and have the highest household disposable income; on the other, the city has the highest proportion of children living in poverty of any region.

Higher disposable income among some groups suggests that more money may be spent on eating out, and this is confirmed by the Family Food Survey, which shows that Londoners eat a higher-than-average quantity of food outside their homes. Half of the nation's restaurants are in London, and this demand has an impact across the food chain, from Primary Production to Disposal.

The relatively high proportion of households living below the poverty threshold may have implications for food access and, by extension, for GHG emissions. Food deserts[7], for example, may be associated with the higher consumption of processed foods – and therefore cause higher GHG emissions in the Manufacturing stage of the food chain - or longer distances travelled to shops for food – and therefore cause higher GHG emissions in the Purchasing stage of the food chain.

In London, community initiatives have sprung up across the boroughs to address some of these problems – we touch on the potential GHG implications of these initiatives later on in this report.

2.4 GHG emissions by food types

Further research is needed to determine the comparative overall greenhouse gas implications of different farming systems, including organic and non-organic production systems; across food types, there is no clear evidence that any one system is more beneficial than the alternatives. For example, in the cases of poultry, eggs and milk, organic production gives rise to more overall GHG emissions[8],[9]; however, the overall environmental impact of the same products is different again when other common agricultural pollutants are taken into consideration (for example nitrate (NO_3), phosphate (PO_4) and ammonia (NH_3)) and other

[7] Food deserts are 'large geographic areas where mainstream grocery stores are absent or distant'. See http://www.fooddesert.net/

[8] Williams, AG, Audsley, E and Sandars, DL (2006). *Determining the environmental burdens and resource use in the production of agricultural and horticultural commodities (Main Report).* Defra Research Project IS0205. Bedford: Cranfield University and Defra

[9] Manchester Business School for Defra (2006) *Environmental Impacts of Food Production and Consumption*

aspects of the environment, for example the water system and soil quality, are included in the analysis.

Similarly, very little UK research has been done on the environmental impacts of different food types across the whole life cycle (including consumer activities and waste disposal). What there is focuses on primary production, and in some cases this extends to processing. There are few studies that cover 'farm to fork' life cycle and there is a strong leaning towards the 'farm' rather than 'fork' end.

Some of the differential impacts of different food types can however be inferred from the literature. For example, Williams et al[10] show that milk and beef production results in relatively high GHG emissions compared to poultry/eggs and fruit/vegetables (note that this comparison does not take into account the different nutritional/calorific values of each food type or the emissions associated with later stages of the food chain).

There is growing evidence about the environmental impact of different diets, with animal proteins giving rise to more GHG emissions than most grains, pulses and outdoor vegetables. The United Nations Food and Agriculture Organisation (FAO) published an in depth study in 2006 about the environmental impacts of livestock across the world. The report found that emissions from the livestock sector are greater than those from transport[11]. It has been estimated that 16% of global methane (the global warming potential of which is 23 times that of CO_2) is produced by livestock[12], and that production of 1kg of beef gives rise to 36.4kg of CO_2eq[13]. Finally, the Food Climate Research Network (FCRN) calculates that livestock products (meat and dairy) account for 8% of the UK's total greenhouse gas emissions; fruit and vegetables about 2.5% and alcoholic drinks about 1.5%[14].

Existing data, although very general, suggests that it is likely that different diets will have different emission profiles. It is also highly likely that, for any given dietary mix, there will be differential GHG impacts at *different stages of the food chain*.

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[10] Williams, AG, Audsley, E and Sandars, DL (2006) *Determining the environmental burdens and resource use in the production of agricultural and horticultural commodities. Main Repor*t. Defra Research Project IS0205 Bedford: Cranfield University and Defra

[11] Food and Agriculture Organisation (2006). *Livestock's long shadow: environmental impacts and options*.

[12] WorldWatch Institute (2004). *State of the World 2004: Special Focus: The Consumer Society*

[13] New Scientist (2007). *Meat is murder on the environment*

[14] Food Climate Research Network (2008). Food and Climate Change (Tara Garnett)

For example, in the case of pasta and potatoes, household use (i.e. preparation/cooking) accounts for the greatest global warming potential in the life cycle of the potato, whilst half the energy used in the spaghetti life cycle comes from cooking.

For fresh carrots, consumer transport is the highest contributor to environmental impacts; in the case of beef the greatest proportion of energy is used in primary production, followed by home preparation. 90% of the global warming potential of the dairy life cycle is in the agricultural stage.

For bottled water, the main environmental impacts are associated with transport and packaging and finally for the fish finger, the global warming impact of home consumption varies depending upon whether you cook them in a microwave or fry them[15].

It is important to note that consideration of both the food production-consumption chain *and* the differential embodied emissions of different food types is necessary for a full picture of the GHG impact of London's food sector, and to inform the choice of actions to address it. The Carbon Trust and the British Standards Institute are currently developing a standard methodology for calculating the embodied CO_2 of products, which will improve the potential for evidence-based policy making in this area.

[15] All figures are from Manchester Business School for Defra (2006) *Environmental Impacts of Food Production and Consumption*

3 GHG Emissions associated with the Food Sector in London

This main section of the report sets out the GHG emissions generated by London's food system. After a brief summary of the findings, each stage of the food production-consumption chain is considered in turn.

3.1 Summary Findings

The following estimates show that the London food sector generates around ***19 million tonnes of CO_2eq per annum***. Of this, just under 11 million tonnes is CO_2.

The London Climate Change Action Plan (LCCAP) estimates that 44 million tonnes of CO_2 are produced within London boundaries. It is important to note that these two sets of figures are not strictly comparable:

- the LCCAP figure refers only to CO_2 from energy consumption, whereas this report includes the bundle of Kyoto Protocol greenhouse gases, or GHGs, expressed as CO_2eq;
- the LCCAP figure refers to CO_2 emissions within London from energy consumption, whereas the food figure captures all emissions, irrespective of their origin, associated with London's food consumption.

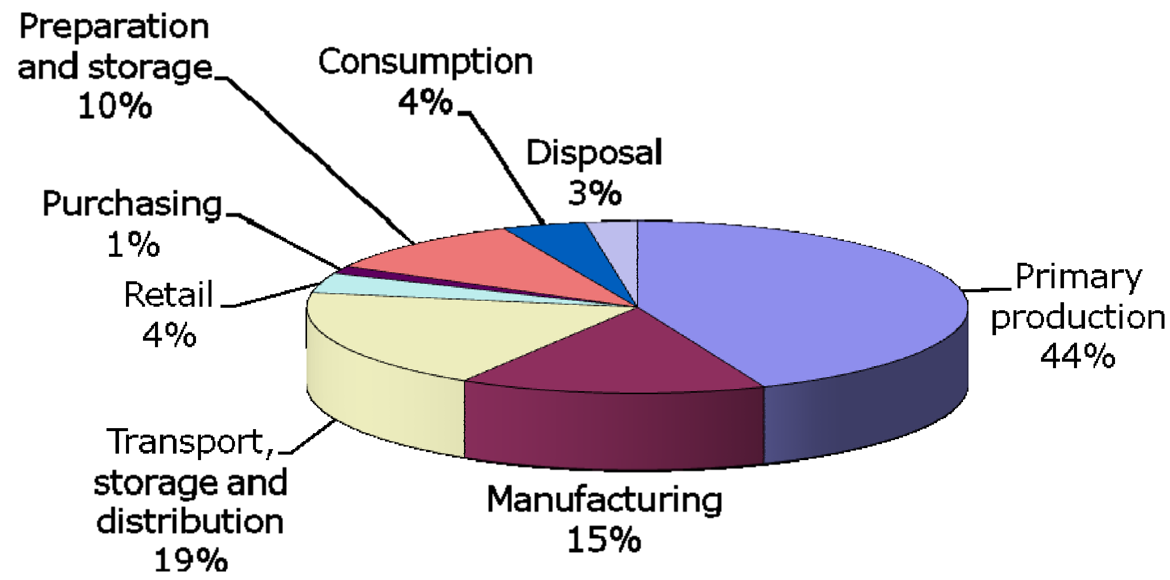
Table 3.1 Total GHG associated with London's food system (1,000 tonnes CO_2eq) 2005

	CO_2	CH_4	N_2O	HFC	PFC	SF_6	Total
Primary production	1,071	2,882	4,238	3	-	-	8,195
Manufacturing	2,748	28	21	4	-	2	2,803
Transport, storage, distribution	3,482	7	45	21	-	-	3,555
Retail	526	5	10	164	-	-	706
Purchasing	265	-	-	-	-	-	265
Preparation and storage	1,964	-	-	-	-	-	1,964
Eating and consumption	723	10	6	17	-	1	760
Disposal	19	448	-	-	-	-	469
Total	**10,800**	**3,380**	**4,323**	**209**	**-**	**3**	**18,716**

Source: Brook Lyndhurst (Totals may not add up due to rounding)

Table 3.1 and Chart 3.1 show that GHG emissions resulting from London's food system span the entire food chain, but are concentrated in the early food production and transport stages. Primary production is the largest contributor to GHG emissions arising from London's food consumption, accounting for more emissions than manufacturing and transport together. These three stages of the food chain account for over three-quarters of all emissions associated with the food sector in London. At the other end of the chain, a tenth of total emissions occur as a result of Londoners' cooking and cold storage of food at home.

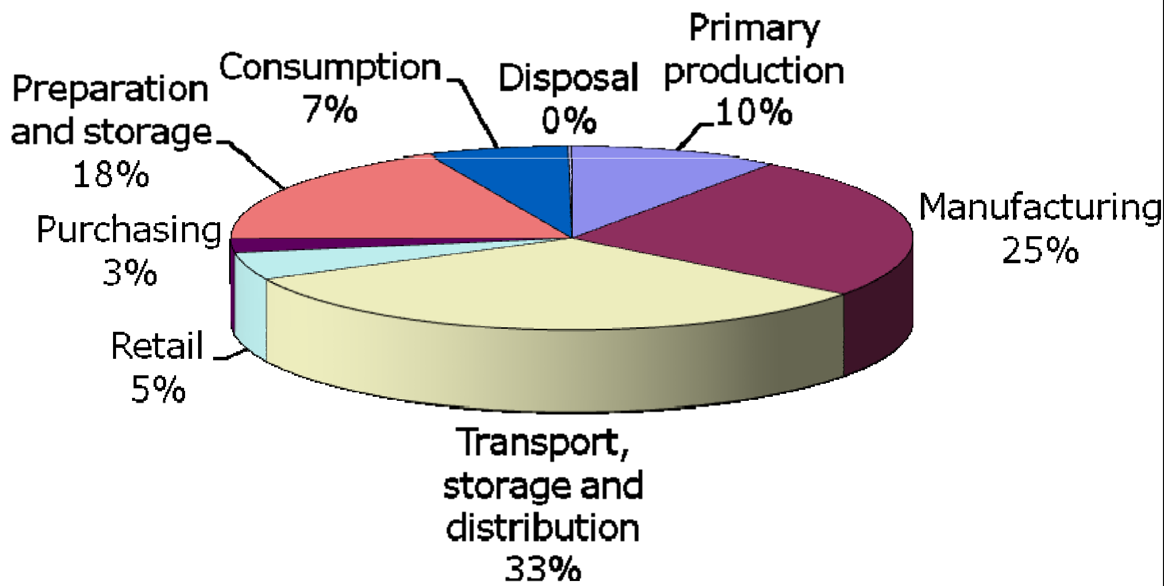
CHART 3.1 Total GHG emissions by stage of the food chain



Source: Brook Lyndhurst

Looking at CO_2 only (Chart 3.2), the picture changes, with Transport, storage and distribution accounting for a third of all CO_2 emissions associated with the food sector in London. Manufacturing and Preparation and storage also account for relatively large shares of CO_2 emissions, producing 25% and 18% respectively of all CO_2 emissions associated with the food sector in London.

CHART 3.2 Total CO_2 emissions by stage of the food chain



Source: Brook Lyndhurst

As noted earlier, some of the GHG emissions associated with the food sector occur within London boundaries whilst others occur predominantly outside London. Although the methodology used in this project does not allow a complete analysis on this basis, it can be assumed that the majority of the GHG emissions associated with the food production stages (Primary production, Manufacturing and Transport, storage and distribution) occur outside London whilst those associated with the consumption stages (Retail, Purchasing, Preparation and cooking, Consumption and Disposal) occur mostly inside London.

On that basis, almost 80% of all GHG emissions associated with the capital's food sector occur at the production stage and, therefore, outside London. At the consumption stage, the food sector emits around 3.5 million tonnes of CO_2eq within London boundaries which is equivalent to around 8% of all GHG emissions in London. (This is a conservative estimate as it does not take into account the production, transport or manufacturing of food within London boundaries.)

Chart 3.3 shows that more than half the GHG emissions occurring outside London can be attributed to Primary production. Chart 3.4 shows that, in London, GHG emissions associated with Preparation and storage account for almost half of all food-related GHG emissions, while the Consumption and Retail sectors are also significant contributors to the environmental impact of the food sector, accounting respectively for 18% and 17% of all consumption-related GHG emissions.

CHART 3.3 GHG emissions arising mainly outside London

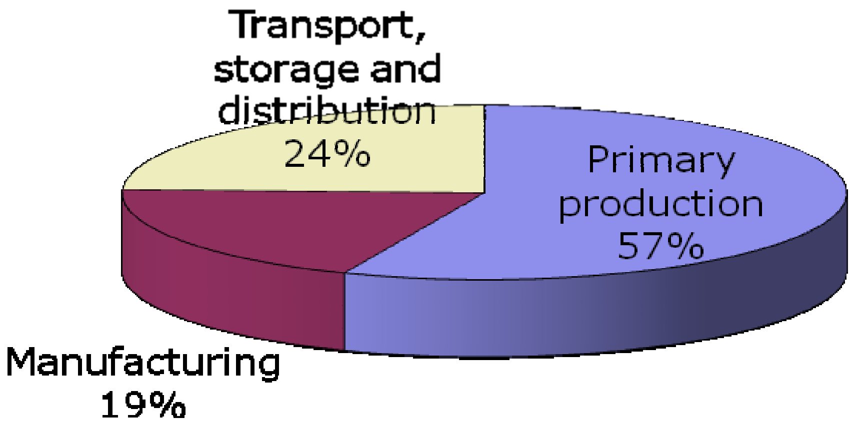
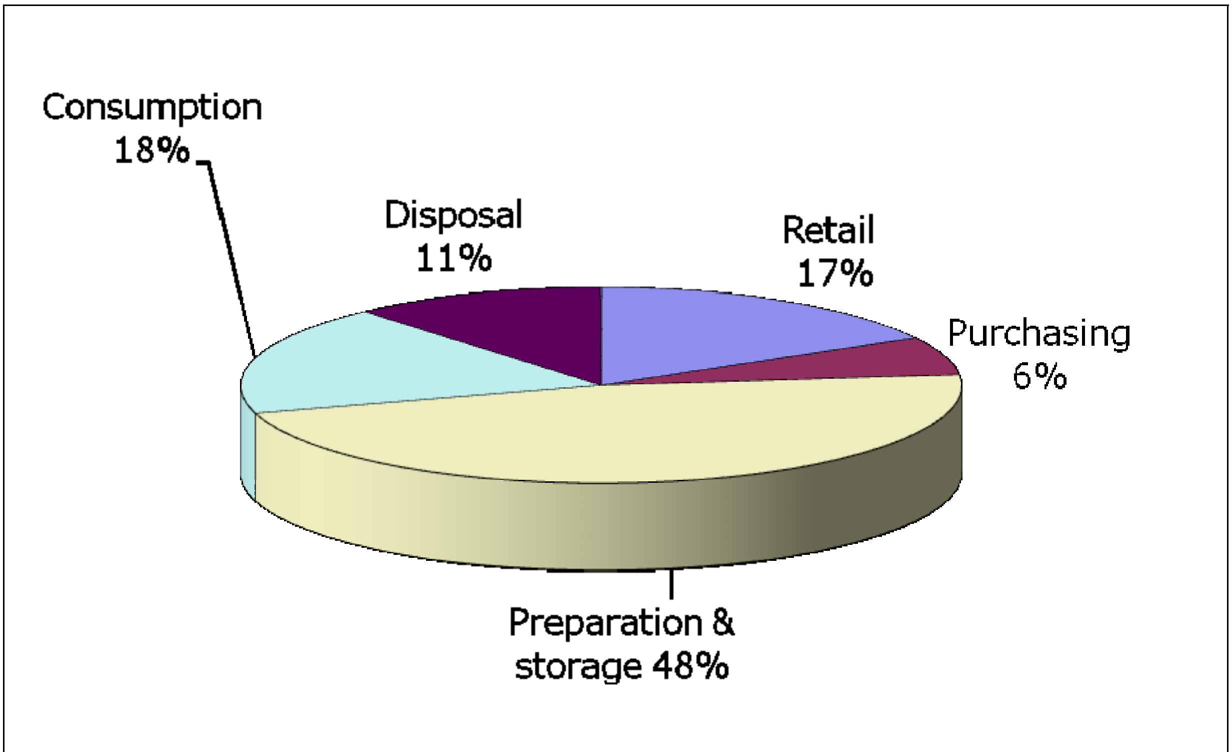


CHART 3.4 GHG emissions arising mainly inside London



Source: Brook Lyndhurst

3.2 Primary Production

Most of the food consumed in London is imported from other regions of the UK and from other countries. As a result, GHG emissions associated with Primary Production arise mainly outside of London.

The starting point is the estimate for GHG emissions from the UK Agriculture and Fishing sectors in the Environmental Accounts. An estimate for GHG emissions associated with imports of agricultural produce is then added to this figure before subtracting an estimate for GHG emissions associated with exports of agricultural produce, to give UK Primary Production consumption emissions.

A major assumption is that the greenhouse gas intensity of food imports is similar to that of UK production. Whilst this is assumption does not take into account the varying efficiencies of overseas production techniques or the composition of exports and imports, data quality precludes a more sophisticated approach, and this is indeed the assumption made by the ONS in its own calculations[16].

[16] Office for National Statistics (2000). *Methodologies for estimating the levels of atmospheric emissions arising from the production of goods imported into the UK.* http://www.statistics.gov.uk/about/methodology_by_theme/environmental_accounts/downloads/Emissions_production_imports.pdf

Table 3.2 GHG emissions associated with Primary Production (1,000 tonnes CO_2eq) 2005							
	CO_2	CH4	N2O	HFC	PFC	SF6	Total
London	1,071	2,882	4,238	3	-	-	8,195
UK	8,640	23,243	34,177	26	-	2	66,089
Source: Brook Lyndhurst							

UK GHG emissions associated with Primary Production are then allocated to London on the basis of London's share of population. This allocation is based on the assumption that food consumption patterns in London are similar to the UK average. A comparison of food consumption patterns in the Family Food Survey between London and the UK as a whole indeed showed differences in consumption to be confined to one or two areas (notably fresh fruit and vegetables and alcoholic drinks).

The impact of tourism on London's food sector is not factored in to this calculation, since the annualized number of nights spent in London by overseas and domestic tourists is more than offset by the annualized number of nights spent by Londoners outside London. The balance is, however, not high enough to make a significant difference to the overall London demand on the food sector.

Similarly, commuters are not factored in to our calculations. London's commuter balance is positive, with a 487,000 net in-commute in 2001[17]. This figure would affect the population slightly; however, assuming that each commuter generally eats only one meal a day (lunch) in the city, and since an unknown proportion of these meals are brought in from outside London, we judged that the effect of these extra people is likely to be small. Moreover, the impact of visitors and commuters are captured in the analysis of the retail and hospitality sectors, so the risk of a significant underestimate is reduced.

As a result, GHG emissions associated with the Primary Production of London's food are estimated to be around ***8.2 million tonnes of CO_2eq***. This may be a slight underestimate due, for example, to Londoners' propensity to consume more primary produce, in the form of fresh fruit and vegetables, than the UK average.

[17] Greater London Authority Labour Market Balance Sheets. http://www.london.gov.uk/mayor/economic_unit/docs/current-issues-note-16.rtf

3.3 Manufacturing

The methodology used to generate an estimate for GHG emissions associated with food manufacturing is similar to that used for the Primary Production stage. Most of the food consumed in London is produced and processed outside the city, and so a top-down methodology is used. GHG emissions associated with the manufacturing of food and beverages are available at the UK level from the Environmental Accounts and are adjusted for imports and exports using assumptions similar to those used for Primary Production. Using UK data as a base means that food manufacturing both inside and outside of London is captured without the risk of double counting emissions.

Table 3.3 GHG emissions associated with Food Manufacturing (1,000 tonnes CO_2eq) 2005

	CO_2	CH_4	N_2O	HFC	PFC	SF_6	Total
London	3,367	34	26	5	-	3	3,435
UK	27,159	273	211	37	-	-	27,701

Source: Brook Lyndhurst

UK emissions associated with food manufacturing are allocated to London on the basis of its share of population and tourism.

In London, GHG emissions arising from the Manufacturing stage of the food supply chain are estimated at ***3.4 million tonnes of*** **CO_2*eq***.

The proportion of high income people and tourists is relatively higher in London than in the UK as a whole, and the eating and spending behaviour of these groups suggest that this GHG figure may be an underestimate.

3.4 Transport, Storage & Distribution

Transport, Storage & Distribution accounts for a significant proportion of GHG emissions associated with London's food. This section includes:

- emissions generated by the fuel used for transporting food by road, rail, air and sea;
- emissions generated by electricity and gas use by food warehouses, distribution centres and wholesale distributors;
- gas and electricity GHG emissions arising from road and rail food transport activities.

It does not include:

- GHG emissions associated with the purchasing of food by households (see Section 3.6);
- GHG emissions associated with retailers' HGVs (see Section 3.5);
- Gas and electricity emissions arising from air and sea transport (NB emissions from fuel use in these sectors **are** included; emissions from gas and electricity use are excluded due to lack of reliable data and to avoid double counting).

The starting point for the analysis is data on food miles related to UK food consumption published by Defra[18]. This report gives the carbon dioxide emissions generated by fuel use for food transport by road, rail, sea and air to UK consumers, including imports.

To avoid double counting emissions, retailers' own HGV fleets are excluded from this section, since they are captured in the Environmental Accounts under Retail. There is also some risk of double-counting emissions from home deliveries made by retailers in their own vans, since these are also captured in the Retail stage. Due to a lack of data on the number of UK vans that are owned by retailers, they have not been excluded from this section. However, the overall figure is likely to be an underestimate since gas and electricity emissions related to air and sea food transport are omitted due to lack of data.

GHG emissions arising from electricity and gas use for transport and storage activities are derived from the Environmental Accounts, and added to the food miles figures. Most of the emissions associated with this stage of the food chain are likely to be generated outside London, although a portion will be generated within London boundaries delivering food to London wholesalers and retailers.

Table 3.4 GHG emissions associated with Transport, Storage and Distribution (1,000 t CO_2eq) 2005

	CO_2	CH_4	N_2O	HFC	PFC	SF_6	Total
London	3,482	7	45	21	-	-	3,555
UK	13,834	26	180	83	-	1	14,124

Source: Brook Lyndhurst

[18] Defra (2005). *The Validity of Food Miles as an Indicator of Sustainable Development*, Department for Environment, Food and Rural Affairs, London

To allocate food miles to London, it is assumed that food transport is closely linked to the Retail and Hospitality sectors in the capital (since food is delivered, in the main, to shops and restaurants rather than consumers). As a result, UK food transport emissions are allocated to London using the value of London's Food Retail and Hospitality sectors as a share of the UK Food Retail and Hospitality sectors.

GHG emissions associated with the Transport, Storage and Distribution stage of the food chain account for ***3.9 million tonnes of CO_2eq.*** According to Defra[19], UK food transport accounted for an estimated 30 billion vehicle kilometres in 2002, of which 82 percent were in the UK. Transport of food by air had the highest CO_2 emissions per tonne, and is the fastest growing mode. Although air freight of food accounts for only 1 percent of food tonne kilometres and 0.1 percent of vehicle kilometres, it produces 11 percent of the food transport CO_2 equivalent emissions.

It is likely that the Defra food miles figure underestimates international transport emissions, since only the last shipment before the product arrives in the UK is included. This means that the London figure is also likely to be an underestimate.

3.5 Retail

Retail GHG emissions at the UK level relate to deliveries made by retailers' vehicles and to the consumption of gas and electricity by the sector. The majority of food retailers' energy consumption is used for food refrigeration[20]. GHG emissions associated with food Retail in London occur both within London (through the use of gas and electricity by the sector and deliveries) and outside (as most retailers' distribution hubs are located outside the M25) but it is not possible to say with precision how much does occur within London boundaries (it partly depends on factors such as congestion in London, distances between stores and distribution hubs and the efficiency of retailers' logistics, etc).

The primary source for estimating retail GHG emissions are the Environmental Accounts. Since GHG emissions in the retail sector are the result of the sector's activity within London's boundaries, the share of London's food retail GVA of UK food retail GVA is used as a proxy for the London share of UK food retail GHG emissions.

[19] Ibid
[20] J Sainsbury Plc (2005). *J Sainsbury Corporate Responsibility Report 2005.*

Using GVA may overestimate London's share of the retail sector, since it does not capture the up-lift on the price of food sold in London. An alternative might be to use food retailing floor space in London and calculate an average emissions intensity per square metre. However, this approach is limited because data on the types of refrigeration units used and energy consumption of London retailers is not readily available. A second alternative would be to calculate London's retail floor space as a share of UK retail floor space and apply this proportion to the Environmental Accounts. However, this method would not capture the economies of scale in terms of lighting and space heating achieved by larger stores. Since any approach to calculating emissions is based on some kind of estimate, GVA is used in this analysis, because this measure may be used consistently with the Environmental Accounts and so ensures the internal consistency of the dataset.

Table 3.5 GHG emissions associated with Retail (1,000 tonnes CO_2eq) 2005

	CO_2	CH_4	N_2O	HFC	PFC	SF_6	Total
London	526	5	10	164	-	-	706
UK	2,681	27	51	834	-	-	3,594

Source: Brook Lyndhurst

It is estimated that GHG emissions associated with the retail sector in London amount to ***706,000 tonnes of CO_2eq***. It is interesting to note that GHG emissions associated with food retailing only account for 4% of all GHG emissions associated with the food sector. This figure includes some transport emissions, namely those associated with retailers' own vehicles.

3.6 Purchasing

The Purchasing stage of the food supply chain is defined as consumer travel to buy food and, therefore, GHG emissions associated with this sector are taken to occur within the London boundaries[21]. GHG emissions from home deliveries are accounted for in the Transport, Storage and Distribution and Retail stages of the supply chain (see Section 3.4 and 3.5). The Environmental Accounts do not cover domestic transport, but the Department for Transport publishes data on personal travel.

[21] At the margin, of course, there will be some journeys by London residents to food shops that are outside the London boundary, and vice versa. We have assumed that these (a) are only a small proportion of total food-related journeys and (b) cancel out.

The first step is to find out the proportion of food shopping out of total shopping and to calculate the number of food-related shopping trips per person per year in the UK. This proportion is only available at the UK level and is therefore used as an estimate for London.

The total number of food shopping miles in London can then be calculated by relating the average number of food shopping trips to the average length of a trip to the supermarket, which is given by a 2007 London Yougov survey. This figure is then grossed up using London's population.

At the UK level, the modes of transport used for food shopping are roughly similar to overall transport patterns. Since Londoners' personal travel patterns are markedly different to those of the rest of the UK, and because modes of transport for food shopping in London are not available, Londoners' overall transport patterns are used to allocate food shopping miles to different modes of transport. Defra conversion factors for the different types of transport are then used to turn London's food shopping miles into GHG emissions.

Table 3.6 GHG emissions associated with Purchasing (1,000 tonnes CO_2eq) 2005

	CO_2	CH_4	N_2O	HFC	PFC	SF_6	Total
London	265	-	-	-	-	-	265
UK	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Source: Brook Lyndhurst

GHG emissions associated with food purchasing account for around ***265,000 tonnes of CO_2eq***. This equates to 2.8% of London's total transport emissions, or 0.6% of London's total CO_2 emissions[22].

Since the bottom-up methodology for working out the GHG emissions for this stage of the food chain was significantly different from the methodology used in the previous stages, this estimate was checked using an alternative approach. Defra estimate that food purchasing miles in the UK give rise to 2,392,000 tonnes of CO_2[23]. Allocating these food miles to London using London's share of UK population, food miles related to purchasing in London are estimated to account for 296,608 tonnes of

[22] Calculated using the London Energy and CO_2 Emissions Inventory (LECI) 2003
[23] Defra (2005). The *Validity of Food Miles as an Indicator of Sustainable Development*, Department for Environment, Food and Rural Affairs, London

CO_2. The difference between the two estimates is to be expected, since the bottom-up estimate reflects London's unique transport patterns and, in particular, lower use of the car for food shopping.

3.7 Preparation & Storage

This stage of the food production-consumption chain relates to emissions generated by Londoners' use of gas and electricity for preparation and storage of food at home.[24]

This stage is not covered by the Environmental Accounts, so the starting point is data on energy consumption (gas and electricity) related to domestic cooking and cold storage for the UK[25]. By applying UK shares of energy consumption related to domestic cooking and cold storage to London's total domestic energy consumption, energy consumption (gas and electricity) related to domestic cooking and cold storage in London can be derived. These gas and electricity use figures are turned into CO_2 emissions using Defra conversion factors.

Table 3.7 GHG emissions associated with Preparation, Storage & Cooking (1,000 tonnes CO_2eq) 2005

	CO_2	CH_4	N_2O	HFC	PFC	SF_6	Total
London	1,965	-	-	-	-	-	1,965
UK	16,117	-	-	-	-	-	16,117

Source: Brook Lyndhurst

It is estimated that GHG emissions associated with Preparation, Storage & Cooking account for around ***2 million tonnes of CO_2eq***, or about 10% of total food related emissions.

Taking the UK share of domestic energy used for cooking and cold storage as an estimate for London may represent a slight overestimate, since Londoners eat more of their meals outside the home than the UK average. However, using local London data on overall domestic energy consumption mitigates this risk somewhat, since this data will capture the overall effect of Londoners using less energy for cooking at home.

[24] NB. This section includes domestic energy use only; see section 3.8, Eating and Consumption, for more details about public sector energy use.
[25] Department for Business, Enterprise and Regulatory Reform (2005). Regional Energy Consumption Statistics. http://www.berr.gov.uk/energy/statistics/regional/index.html

It is worth noting that this estimate does not capture other GHGs arising from refrigeration; for example, HFCs are a common refrigerant used in domestic refrigeration appliances. There is currently no reliable data on the number of fridges disposed of per year or the varying levels of GHG leakage associated with different models and disposal techniques. However, this omission is not likely to have much of an impact on overall GHG emissions associated with this stage of the food chain as energy use accounts for 96% of total emissions associated with domestic refrigeration[26].

3.8 Eating & Consumption

Eating and consumption relates to the emissions arising from food and beverage consumption outside the home in London. This stage of the food supply chain comprises restaurants, quick service (fast food, cafés, takeaway), pubs and catering.

Food consumption in hotels is not included in this analysis as it has not proved possible to disentangle GHG emissions due to food preparation from other GHG emissions in hotels. Also, the Eating & Consumption figure covers food services in the health, education and public services only if these services are sub-contracted to London-based catering firms.[27]

At the UK level, GHG emissions in the Hotels and Restaurants sector from the Environmental Accounts are scaled down to exclude Hotels using National Accounts data. UK GHG emissions in the Eating & Consumption stage are allocated to London using London's GVA share in that sector.

[26] European Commission (2004)
http://eescopinions.eesc.europa.eu/eescopiniondocument.aspx?language=EN&docnr=0100&year=2004)
NB. This refers to 96% of global warming potential of all GHG emissions resulting from domestic refrigeration.
[27] This means that the public sector is only partially and indirectly included in the 'Eating and consumption' section. The Environmental Accounts (EA) code 62 and Standard Industrial Classification (SIC) 55 give emissions and GVA (respectively) for the 'Hotels and restaurants' sector. This includes privately run canteens and catering (SIC 55.5), of which some will be located in public sector institutions. However, the data are not disaggregated by location of business or type of host institution, so this study does not differentiate between school/hospital canteens and private sector restaurants. These reasons of data availability led us to include a separate section on the public sector (see section 4.3 of the report).

Table 3.8 GHG emissions associated with Eating & Consumption (1,000 tonnes CO_2eq) 2005							
	CO_2	CH_4	N_2O	HFC	PFC	SF_6	Total
London	723	10	8	17	-	1	760
UK	3,099	43	35	74	-	3	3,255
Source: Brook Lyndhurst							

In London, GHG emissions from the Eating & Consumption stage of the food chain account for around ***760,000 tonnes of CO_2eq***.

This figure is likely to be an underestimate of GHG emissions associated with Eating and Consumption as it does not take into account food consumed in hotels or in other public spaces where food is prepared by in-house caterers.

3.9 Disposal

In the UK, there are three sources of waste related to the food sector. These are:

- agricultural manure and slurries, accounting for 88 million tonnes;
- other agricultural waste, accounting for 7 million tonnes; and
- non-agricultural food-related waste[28], from both commercial and household sources, accounting for 20 million tonnes[29].

However, agricultural manure and slurries are not technically classified as waste as these are mostly re-used on farms as a soil enhancer or used for biogas generation. There is also very little information regarding the treatment of other agricultural waste (and it is the treatment of waste which significantly determines its GHG impacts). As a result, this report focuses on food-related waste generated by households and industry.

The Environmental Accounts provide an estimate of GHG emissions associated with the solid waste sector at the UK level. Only emissions from waste sent to landfill or incinerated without energy recovery are included in that sector of the Environmental Accounts. The most significant GHG produced by waste is methane. It is estimated that

[28] In this report, the term 'food-related waste' includes both food waste and waste generated around food items. As such, it includes packaging used for food and beverage and non-food waste produced by the food and drink industrial sector.
[29] Cabinet Office, The Strategy Unit (2008), *Food: An Analysis of the Issues*

landfilling of waste globally contributes to between 5 and 20 per cent of total methane emissions arising from human activities. Other sources of GHG emissions in the solid waste sector include vehicles and incineration. As a result, GHG emissions associated with waste mostly arise outside London; for example, although 70% of London's municipal waste goes to landfill[30], there are only two landfill sites within London boundaries that accept municipal waste[31] .

Emissions from recycling, composting and Energy from Waste (EfW) are excluded from the Environmental Accounts solid waste sector, and hence from this analysis. (The reason for this is that they are captured elsewhere in the Accounts, predominantly in the energy production sector, and to include them within the Disposal calculation would result in double-counting). However, it is important to note that the emissions produced from the incineration of food-related waste (particularly plastics – it is important to recall that 'food waste' includes packaging as well as organic waste) operating in electricity mode only are likely to be greater than the emissions saved from generating electricity. Recycling food-packaging waste offers the greatest greenhouse gas savings due to the avoided emissions associated with virgin production of material[32]. Biological treatment of organic food waste (e.g. composting or anaerobic digestion) offers greater emission savings compared with incineration, particularly when coupled with energy recovery.

In order to generate GHG emissions associated with waste, data on the overall tonnage of municipal, commercial, industrial and construction and demolition[33] and excavation waste in both London and the UK were collated. The amount of municipal and industrial waste related to the food sector was then estimated using waste composition data for municipal waste and detailed sectoral data for industrial waste.

The next step was to estimate how much of this food-related waste is potentially recyclable/compostable. Since data about methods of treatment are available for both municipal and industrial waste, the quantity of waste potentially recyclable/compostable that is actually recycled is estimated and excluded from the overall estimate of food-related waste. Waste that is treated through EfW was also excluded for the reasons explained above.

[30] London Development Agency (2008). *The London Plan 2008*.
[31] Rainham in LB of Havering and Beddington Farm in Sutton.
[32] Greater London Authority (2008). *Greenhouse gas balances of waste management scenarios*.
[33] C&D waste that goes to landfill only.

Table 3.9 GHG emissions associated with Disposal (1,000 tonnes CO_2eq) 2005							
	CO_2	CH_4	N_2O	HFC	PFC	SF_6	Total
London	19	448	-	-	-	-	469
UK	140	3,244	2	3	-	-	3,390
Source: Brook Lyndhurst							

The calculations[34] suggest that food-related waste sent to landfill or incinerated amounts to around 13 million tonnes in the UK and that this accounts for around 17% of all waste sent to landfill or incinerated. In London, food-related waste is estimated to be around 1.8 million tonnes and accounts for 25% of all waste sent to landfill or incinerated. This difference between London and the UK is due to the fact that municipal waste in London accounts for a greater share of total waste than in the UK as a whole.

By applying the share of food-related waste in the UK to overall GHG emissions in the solid waste sector, GHG emissions associated with food-related waste in the UK can be derived. These are estimated to be around 3.4 million tonnes of CO_2eq. This is similar to the findings published by the Strategy Unit report[35] which found that waste from the food chain generates 3 million tonnes of CO_2eq. In London, GHG emissions associated with food-related waste are estimated to amount to around ***469,000 tonnes of CO_2eq***.

It is important to note that this figure is actual emissions – it does not include emissions that are 'offset' by recycling or other waste treatment.

This analysis shows that GHG emissions associated with food waste only account for some 2% of all GHG emissions related to the food sector in London; however, this figure is not representative of the true environmental impact of wasted food and packaging. It is worth noting that a significant amount of 'edible' waste – waste that could have been eaten - is generated every year. The Sustainable Development Commission[36] estimates that this edible waste is worth £250-£400 per household per year, and the overall retail value of the food waste that

[34] All figures in this section are derived from a variety of data sources, including DEFRA, WRAP and the Environmental Accounts. Full details can be found in the Appendix.
[35] Cabinet Office, The Strategy Unit (2008), *Food: An Analysis of the Issues*
[36] Sustainable Development Commission, (2007), *Green, Healthy and Fair: A Review of Government's Role in Supporting Sustainable Supermarket food*

goes to landfill is calculated to be £6 billion per year, including the edible waste. The Waste and Resources Action Programme (Wrap) estimate that around a third of all food bought by households is thrown away, half of which is edible food waste.

Wasted food not only produces emissions in its own right, but represents 'wasted' embodied emissions from its production, transport and storage. Reducing edible waste would therefore reduce GHG emissions not only at the Disposal stage but also throughout the food production-consumption chain.

4 London issues

4.1 Introduction

Having set out in Section 3 the detailed quantification of GHG emissions associated with London's food system, this section of the report presents a range of more qualitative arguments and analyses.

These arguments refer to a range of issues, identified by the GLA when specifying this research, with some potential to have an impact upon London's food-related GHG emissions. Many of the issues raised in the original project specification have been formally incorporated into the quantitative approach; others, however, for reasons either of excessive complexity, or their small size, or – most frequently – a lack of available data, need separate treatment.

In this section, therefore, a mix of qualitative and quantitative evidence on the likely scale and impact of a range of issues is presented. These issues can be contextualised by the quantitative material presented in Section 3, as users of this research deliberate on its implications.

4.2 Context

London's food comes from an extraordinary variety of sources. The city is a mosaic of small businesses – speciality food shops, family owned restaurants – that compete with the market-dominating grocery multiples and global chain restaurants. The public sector provides food for London's hospital patients, school children, prisoners, civil servants and the military, and also supports community-based initiatives that aim to address food access problems. Many Londoners have a choice of farmers' markets and street markets in which to buy their food, and some even grow their own produce in allotments and green roofs. Then there are one off events, such as the London 2012 Olympic and Paralympic Games, during which London will provide food for hundreds of thousands of visitors, athletes and journalists. All of these food sub-systems have their own pattern of GHG impacts, positive and negative, large and small.

Just as all the stages of the food chain link to each other, these issues interconnect and interact with multiple stages of the food chain. For example, London's high proportion of ethnic minority groups poses special challenges for the city's hospital food provision, which in turn influences the type of supplier the hospitals use (for example, wholesalers, farmers' markets, national ready-meal suppliers), the type of food procured (for example, processed, unprocessed, organic), where the food is transported from (imported, UK grown, local), and how food is prepared (cooked from scratch, reheated). Each of the options gives rise to differing quantities of GHGs, and has wider implications for the sustainability of the food system.

It is beyond the scope of this project to attempt to quantify the GHG impacts of all of these considerations in the context of London's overall food system. However, the purpose of this section is to take a closer look at the sectors that have the most significant impact on the food system and to give an idea of their likely implications for climate change.

To decide which factors are most significant, an indicator of the scale of each issue is required: these indicators unavoidably vary from issue to issue (the means of quantifying the London 2012 Olympic and Paralympic Games is simply different from the quantification of allotments) but, as far as possible, these issues are positioned in terms of their share of London's food system. Put crudely, there are approximately 8 billion meals eaten in London during the course of a year: issues that account for, or influence, a larger proportion of these meals are taken to be more significant (in GHG terms) than those that affect only a small proportion.

Three issues emerged from the analysis as having conspicuously large GHG consequences:

- public sector procurement;
- the retail sector; and
- the hospitality sector.

Each of these is considered in turn, below. A range of other, smaller issues, are discussed in the final sub-section.

It is important to stress that this section complements Section 3 by providing a fuller picture of some of London's unique issues. It is neither an exhaustive list nor a comprehensive view of all the elements of the city's food system; it is simply an illustration of some of the main factors that were judged to be important when thinking about the climate change implications of London's food.

4.3 Public procurement

London's schools and hospitals serve around 110 million meals per year

The UK government recognised the importance of public sector food procurement when it launched the Public Sector Food Procurement Initiative (2003). The potential of the public sector to influence the environment through its food procurement was made explicit - one of the five priority objectives of the PSFPI is to reduce adverse environmental impacts of food production and supply.

The NHS in London, including some 70 hospitals[37], serves around 37 million meals a year to its patients and staff and in 2002 had a £15.5m food budget. London's schools serve an estimated 76.5 million meals per year. This means that London's schools and hospitals alone serve over 110 million meals per year[38]. There are nine public sector prisons in London with a combined operational capacity of 7,476; if all of these places are filled, this equates to over 8 million meals per year. Other public sector bodies in London that source food include local and central government, armed forces bases, universities, residential homes and other publicly funded organisations. Overall, 22% of London's population is employed in the public sector[39].These figures suggest that the potential GHG impacts of public sector food will be significant.

Different food procurement practices influence the food chain in different ways and therefore have varying environmental impacts. To illustrate this, this report looks at the London Food Link "Hospital Food Project" that ran between 2004 and 2005. Out of the four hospitals that took part in the project, three used a national supplier of ready-made meals, whereas one sourced all its food at a wholesaler based in London's Spitalfields market. For illustrative purposes, these different procurement practices are compared from a GHG perspective, below[40].

Example 1 - St George's Hospital Tooting
Sources ready-meals from a single manufacturer

Summary

[37] London Health Observatory (2008)
[38] National Audit Office (2006). *Smarter food procurement in the public sector*. NAO, London
[39] GLA Economics Working Paper 24: *An analysis of London's employment by sector*
[40] For an additional example of good practice, see details of the Royal Cornwall Hospital Trust, which has achieved a 67% reduction in the annual 'food miles' travelled by food delivery vans. http://www.localfoodworks.org/Web/SA/saweb.nsf/94b4d558e66793c680256fa800349138/303549f881a7a217802572d50056b270/$FILE/hospital_food.pdf

- The ready-meal manufacturer has two factories (Colchester and Manchester) which produce standardised meals for public sector customers in all UK locations
- The supplier transports the meals to hospitals in London using its own fleet of temperature controlled vehicles
- Meals are regenerated (reheated) in hospital kitchens

In principle, there is a range of factors that are likely to reduce the GHG consequences of this procurement method (in comparison to an alternative); and a range likely to increase the GHG consequences. In the tables below, we sketch out some of these "in principle" impacts. No significance should be derived from the order in which these items appear; and it should be noted, too, that the positive or negative impacts of any given issue could be large or small (i.e. a single 'negative' impact could dwarf the total of positive impacts, and vice versa).

Table 4.1 GHG reduction factors related to St George's Hospital procurement policy
Mass production of food gives rise to some GHG "economies of scale", such as the use of large, energy efficient ovens.
Transporting meals from Colchester (70 miles away) gives rise to transport emissions, but GHG efficiencies may be gained from the use of large vehicles that deliver to multiple hospitals in one trip, especially if efficiency measures such as load optimisation are in place[41].
Refrigerated vehicles may reduce food waste (although the relationship is not simple or linear)[42].
One Swedish study found that domestic ready meals produce fewer overall GHGs than freshly prepared equivalents.[43]

Table 4.2 GHG increase factors related to St George's Hospital procurement policy
Centralised manufacturing limits the possibility of incorporating 'local' ingredients into food, which may result in increased overall food miles.
A longer and more complex supply chain leads to multiple transport stages. Emissions also arise from transporting primary produce and other inputs to the manufacturer. It also leads to some food types being stored and refrigerated for longer, increasing energy consumption.

[41] Transport 2000 Trust (2003). *Wise moves: Exploring the relationship between food, transport and CO2*. Tara Garnett.
[42] Food Climate Research Network (2007). Food refrigeration: what is the contribution to greenhouse gas emissions and how might emissions be reduced? Tara Garnett.
[43] Sonesson, U; Mattsson, B; Nybrant, Ohlsson, T (2005). Industrial processing versus home cooking: an environmental comparison between three ways to prepare a meal. Royal Swedish Academy of Sciences.

Refrigerated vehicles use more energy than standard vehicles.
Emissions arise from the production and disposal of packaging for processed foods, especially plastics, which are derived from fossil fuels.
The design of packaging may lead to cooking inefficiencies; for example, even if only one of a certain type of meal is ordered, there may be a minimum number that have to be reheated. This wasted food also entails the waste of all the embodied emissions from the production and transport of the food.
Other transport GHGs relate to empty supplier vehicles returning to Colchester.

Example 2 - Royal Brompton Hospital, South Kensington
Sources unprocessed products from variety of suppliers

Summary

- Large proportion of unprocessed meat purchased from independent catering butcher
- Other ingredients purchased from wholesaler
- Food cooked from scratch in hospital kitchen

As before, we can identify a range of possible positive and negative impacts in GHG terms.

Table 4.3 GHG reduction factors related to Royal Brompton Hospital procurement policy
Purchasing unprocessed food means GHGs from food manufacturing are not part of this hospital's food-related GHG profile.
Unprocessed produce may come in less packaging.
Purchasing food locally may mean fewer food miles per meal, depending on the procurement practices of the wholesaler and butcher.

Table 4.4 GHG increase factors related to Royal Brompton Hospital procurement policy
Purchasing from wholesalers/suppliers in a hospital-owned white van for a single end user may lead to increased 'food miles' per meal than a centralised distribution system with vehicles that carry a larger quantity and deliver to many users[44]. This depends on the distance driven and the efficiency of the van; however, in general, light goods vehicles are less efficient and produce a higher proportion of nitrous oxide than larger heavy

[44] Transport 2000 Trust (2003). *Wise moves: Exploring the relationship between food, transport and CO2. Tara Garnett*.
[45] London Atmospheric Emissions Inventory (LAEI)

goods vehicles[45].
More energy may be used by the hospital kitchen to cook food from scratch due to the lower energy efficiency of smaller ovens and depending on the cooking method used[46].
Peelings and other food elements that end up as waste are transported all the way to the hospital kitchen, which increases overall transport emissions per unit of food consumed.

Food's role in the NHS's environmental impact is covered at the national level by the ten-year 'Better Hospital Food Initiative' and the PSFPI. As well as these frameworks, the NHS Purchasing and Supply Agency (PASA) acts as a strategic adviser to the NHS on procurement, and may provide a potential central focus for actions to tackle the GHG impact of food procurement. In addition, as part of the implementation of the Mayor's Food Strategy, the London Development Agency runs a public sector training programme called Good Food Training for London[47], and its Local Food Infrastructure project will seek to facilitate the use of sustainable food by London's public sector.

As these examples show, there are no straightforward ways to reduce the GHGs arising from public sector food procurement. However, due to the magnitude of London's public sector food procurement, reducing this sector's emissions could potentially have a significant influence on London's overall food-related emissions. This potential will perhaps be easier to realise given the high visibility of public sector food as an issue and the already existing policy context at both the UK and London levels.

4.4 London's food retail structure

- London's food retail sector accounts for 19% of the value of the total UK market[48]
- London will need 1-1.5 million square metres of extra retail floor space by 2016 if consumers continue to shop at the same rate[49]

The market concentration of the large grocery multiples is relatively high in London, with 70% of all one-stop shopping taking place at a Tesco or Sainsbury's, compared to 55% in the rest of the UK[50]. London has the lowest proportion of superstores (stores over 25,000sq feet) of any

[46] Manchester Business School for Defra (2006) *Environmental Impacts of Food Production and Consumption*
[47] See http://www.sustainweb.org/page.php?id=380 for more details
[48] See Section 3 of this report.
[49] GLA Economics (2005). *Retail in London: Working Paper C. Grocery Retailing*.
[50] London Development Agency (2006). *Healthy and Sustainable food for London: The Mayor's Food Strategy*.

region[51], and 43% of Londoners shop in supermarket convenience stores, compared with 31% in the UK overall[52]. The expansion of supermarkets into the local convenience sector is supported in London by various factors, including:

- the highest population density of all regions;
- the size of the city;
- the tendency of Londoners to food shop more frequently because of pressure on time and on storage space[53];
- relatively high access to local public transport;
- less available land for superstores.

With the large retailers playing such a major role in London's food system, the GHG impact of that system is clearly linked to those retailers; in fact, their impact is apparent across the entire food chain. Supermarkets are major customers for the primary production and food manufacturing sectors, whose activities and production techniques are heavily influenced by the supermarkets. Their global supply chains rely on a vast and sophisticated road, rail, sea and air transport network. Supermarkets' choice of site influences how customers travel to the shops to purchase their food, and how often they go. Food from supermarkets is cooked in people's homes and in some catering outlets, and waste may be thrown away and end up in landfill[54].

Some of the GHG implications of different aspects of London's food retail system are considered in more detail below.

Example 1 – Travel patterns to large and convenience stores

In the London Borough of Hammersmith and Fulham, a large Tesco and a Tesco Express (convenience store) are located less than half a mile apart. However, the size and site of each store has a significant impact on the travel patterns of customers.

Large store

- Located in a mainly residential area

[51] Calculated from DEFRA (2005). *The economic position of the agri-food sector - regional analysis*.
[52] Transport for London (2006). *Factors affecting the structure and pattern of retailing in London*. http://www.london.gov.uk/gla/publications/econ-dev/retail-in-london.pdf
[53] Transport for London (2006). *Factors affecting the structure and pattern of retailing in London*. http://www.london.gov.uk/gla/publications/econ-dev/retail-in-london.pdf
[54] As mentioned above, WRAP estimate that as much as one third (by weight) of all food bought by consumers is thrown away, of which half is edible; while a compositional study conducted in S E London suggests that as much as 20% of food waste is *still in its original packaging*.

- Accessed from a busy road
- Has a large car park
- The size of the shop means that a larger proportion of customers tend to do their weekly shop there

Potential positive and negative GHG impacts include:

Table 4.5 GHG reduction factor related to travel to large store
The large store's location in a residential area may mean that a relatively larger share of customers walk to it, especially for top up shopping.

Table 4.6 GHG increase factor related to travel to large store
The presence of a car park at the large shop, as well as the average quantity of purchases, encourages customers to travel in their cars, even if they live locally.

Convenience store

- The convenience store is located at the end of the high street in the shopping precinct attached to the underground and local bus stations

Again, positive and negative possibilities include:

Table 4.7 GHG reduction factors related to travel to convenience store
At the convenience store, customers are more likely to be passing trade or doing top up (secondary) shopping, which means they have generally arrived on foot or by public transport[55].
There is no car park for the convenience shop, so customers and staff are unlikely to drive to the shop.

Londoners are less car dependent than the UK average: 35% of Londoners do not have a car, compared to 24% in the UK overall[56]. It is likely that a relatively small proportion of London supermarkets have a car park due to land availability and cost, which further discourages car-borne shopping in the capital (although it may mean that people travel further distances in their cars to go to a shop with a car park). It is possible, of course, that the example convenience store above was

[55] University of Southampton (2005). *Consumers respond to transformation in UK convenience store sector*. http://www.soton.ac.uk/mediacentre/news/2005/nov/05_191.shtml
[56] Department for Transport (2005). *Focus on Personal Travel*

located near to public transport precisely because the retailer took into account London's large population of non-car users[57].

The example shows how the site and size of the shop and the facilities it has (for example, a car park) all influence the mode of transport that customers use for food shopping, and therefore the GHG consequences of their purchases. This is confirmed by the fact that UK planning policy has, since 1996, focused on reversing the shift to out-of town retailing, partly because of the car dependence that this retail model generates[58]. It also seems likely that the distance between household and shop is not the only factor driving car use, but the nature of the trip (main weekly shop or top up) is also important. These factors clearly apply to all small local shops, not just supermarket convenience stores.

There is growing evidence on the potential for home delivery and e-commerce to reduce the GHG emissions associated with supermarket shopping, with various studies finding that internet shopping reduces total emissions[59],[60]. However, home delivery of individual food sub-groups (e.g. vegetables) is more likely to complement 'traditional' shopping than to substitute for it, which may increase shopping-related road traffic.

Example 2 – Links to primary producers

Although London's food retail sector is dominated by supermarkets, the city has a relatively large share[61] of independent, speciality food shops, which are supported by the capital's unique demographic and urban structure, as well as its ethnic diversity, high levels of disposable income and high number of tourists. London also has a strong market sector, with wholesale markets supplying 20% of the city's fresh meat, fish, fruit and vegetables[62], and various street and farmers' markets.

Farmers' markets – consumers buy directly from producers

- There are 13 London farmers' markets listed by the National Farmer's Retail and Market Association (FARMA), plus a number of 'unofficial' farmers' markets

[57] GLA Economics (2006). Retail in London: Working Paper J. *The impact of planning on competition and productivity*.
[58] Ibid
[59] Siikavirta, H, Punakivi, M., Karkkainen, M and Linnanen, L. (2005), *Effects of E-Commerce on Greenhouse Gas Emissions, A Case Study of Grocery Home Delivery in Finland*. Journal of Industrial Ecology, Vol 6, No 2, 83-97 (http://www.mitpressjournals.org/doi/pdf/10.1162/108819802763471807?cookieSet=1)
[60] Cairns, S. (2005), *Delivering Supermarket Shopping: More or Less Traffic?* Transport Reviews, Vol. 25, No. 1, 51–84, January 2005
[61] London Development Agency (2006). *Healthy and Sustainable food for London: The Mayor's Food Strategy*.
[62] Ibid

- The principal producer must run the stall, and all produce sold must be grown, reared or caught within a defined local area

Table 4.8 GHG reduction factors related to farmers' markets
Food transport emissions are reduced due to the removal of intermediate distribution activities between the producer and customer.
Energy consumption for storage may be reduced since produce may not be warehoused/stored before being sold.
Energy consumption for lighting and space heating is likely to be lower than for other types of retailer, especially at outdoor markets.
Packaging is minimised in produce direct from the farm.
People are more likely to walk to a farmers' market – one study that looked at four London street markets showed that the two most popular forms of transport were walking (47%) and car (32%)[63].

Table 4.9 GHG increase factors related to farmers' markets
Food transport emissions may be increased due to the larger number of smaller vehicles used by producers to transport goods to market.
Some products are more GHG intensive when produced locally in the UK; for example, vegetables grown in temperature controlled greenhouses in the UK may have more embodied energy than field grown vegetables imported from

ASDA supermarkets – centralised distribution network

- 347 stores across the UK
- 27 distribution centres across the UK[65]
- Operates just-in-time (JIT) production techniques

ASDA, like other supermarkets, is a major customer for farmers. The Competition Commission has (repeatedly) highlighted the effects of the large supermarkets on primary producers, with the buying power of the supermarkets, coupled with some "unfair" trading practices, causing rising costs along the supply chain to fall disproportionately on farmers.

The supermarkets' influence over their suppliers also, however, extends to environmental standards. For example, Tesco's aim to put a carbon rating on all its products is predicted to force manufacturers to adopt more environmentally sound processing techniques[66].

[63] New Economics Foundation (2005). *Work Study on the Local Economic Impact of Street Produce Markets and Farmers' Markets*.
[64] Defra (2005). *The validity of food miles as an indicator of sustainable development: Final report*
[65] IGD (2008). Supply Chain Analysis http://supplychainanalysis.igd.com/index.asp?id=16&retid=1
[66] Food and Drink Europe (2007). *Tesco carbon rating to force greener processing*. http://www.foodanddrinkeurope.com/news/ng.asp?n=73962-tesco-airfreighting-greenhouse

Table 4.10 GHG reduction factors related to supermarkets
Centralised distribution leads to higher vehicle efficiencies and therefore lower transport emissions at the aggregate level[67] than non-centralised supermarket supply chain management.
JIT production reduces retailer wastage of fresh produce.
Large stores often achieve energy consumption economies of scale in terms of lighting, space heating and refrigeration.

Table 4.11 GHG increase factors related to supermarkets
Centralised distribution increases emissions for some product types, especially if packaging and storage take place in different locations[68].
JIT production often increases waste at the primary production stage, as farmers may over produce to ensure they can meet unpredictable quotas.
Centralised distribution makes it easier for overseas suppliers to penetrate the UK market, which may increase food miles. This is illustrated by the fact that in 2002, over half of imported produce was indigenous (i.e. could have been produced in the UK)[69].
Cosmetic specifications set by supermarkets may lead to increased waste[70].
The high cost of land and labour in London may mean that London food retailers have relatively longer UK supply chains (and therefore more associated transport emissions), since food production is more likely to take place outside of London. This applies more to the type of product that is still delivered directly to supermarkets by suppliers – for example, milk, bread and eggs – than products that are supplied through national or regional distribution centres.

Example 3 – Investment in environmental R&D

The potential for investment into the research and development of new technologies and environmental practices is particularly high among the large supermarkets. For example, in 2006-07, Tesco ring-fenced £100 million to develop renewable energy sources for its stores. Various bodies have been established to coordinate effort: for example, the Retail Energy and Environment Club[71] facilitates knowledge sharing among retailers. Moreover, increasing pressure from customers and shareholders for the retailers to reduce their environmental impact, and Climate Change

[67] Defra (2005). *The validity of food miles as an indicator of sustainable development: Final report*
[68] Ibid
[69] Defra (2005). *The validity of food miles as an indicator of sustainable development: Final report*
[70] Greenpeace (2003). *Ten Reasons why Supermarket Mergers are Bad for Consumers.* http://www.foe.co.uk/resource/press_releases/20030113134910.html
[71] www.thereec.co.uk

Agreements that cover some aspects of food retailing, incentivise supermarkets to act.

Climate change initiatives by national supermarkets will affect London's food system emissions, due to the proportion of the capital's food that is supplied by the largest supermarkets.

Some examples of this kind of business initiative include:

- ASDA, Co-op and Marks and Spencer all aim to become carbon neutral.
- Tesco is aiming to achieve a 50% reduction in the carbon dioxide emissions from its stores and distribution centres by 2020.
- ASDA and Marks and Spencer aim to send no waste to landfill by 2010 and 2012 respectively.
- Sainsbury's aims to cut waste by 50% by 2010 and Tesco aims to cut waste by 80% by 2009.
- One of Tesco's environmental flagship stores has achieved a 20% reduction in its energy consumption through use of a range of technologies, including wind turbines to power tills, cold air recycling systems, light sensors and clear Perspex panels in the roof to maximise natural light.

If Tesco alone achieved its 50% reduction in CO_2 emissions, London's food system emissions would be reduced by some 75,000 tonnes of CO_2 per year[72]. London Sainsbury's stores produce around 28,000 tonnes of waste per year, so a 50% reduction would save London 14,000 tonnes of waste[73]. All of this highlights the importance of the large retailers in tackling the climate change implications of London's food system.

4.5 Hospitality

- There are over 12,000 restaurants in London[74], most of which are independently owned[75]
- Added to this are over 6,000 cafes and over 5,000 pubs/bars[76]
- In 2007 there were around 103,000 hotel rooms available in London[77]. 75% of these are in branded (chain) hotels[78], the three biggest of which are Hilton, Thistle and Premier Travel Inn

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[72] Calculated from figures in Tesco (2006) Corporate Responsibility annual report
[73] Calculated from figures in Sainsbury's (2005) Corporate Responsibility annual report
[74] London Development Agency (2006). *Healthy and Sustainable food for London: The Mayor's Food Strategy*.
[75] Keynote (2007). Restaurants
[76] London Development Agency (2006). *Healthy and Sustainable food for London: The Mayor's Food Strategy.*
[77] PriceWaterhouseCoopers (2002). *Demand and capacity for hotels and conference centres in London*. PWC/GLA 2002.

- Brook Lyndhurst estimate that London's hotels serve in the region of 30 million meals per year

Hotel and restaurant food procurement has a direct impact on various stages of the food chain and the GHG emissions arising from each. Some London restaurants are supplied directly by local producers, who deliver their produce themselves on a regular basis, while some source their ingredients from wholesalers, and others use large scale national suppliers. The primary production and manufacturing sectors provide fresh and processed ingredients, and all inputs, whether processed or unprocessed, have to be transported to London. Electricity and gas are used in the preparation and storage of food in restaurants and for space heating and lighting. Londoners travel to eat out using various modes of transport which have varying emission effects, and restaurant food waste may end up on landfill sites, where it produces methane.

Below, again for illustration purposes, the differing emissions profiles of two different types of restaurant are considered.

Example 1 - Small Independent[79]

- 5 sites in London, sources ingredients and products from various suppliers
- Vegetables are purchased at Chef's Connection in Covent Garden
- No fruit is air-freighted
- Meat is from local suppliers
- Cakes are from a farm in Dorset that sources ingredients locally
- 64% of food is sourced within the UK
- Largest market is passing lunchtime foot trade

Table 4.12 GHG reduction factors related to small independent restaurant sourcing policy
Opting for local suppliers may shorten supply chains and decrease emissions from food miles.
Using fresh ingredients decreases the amount of packaging and associated GHGs.

[78] http://www.milesfaster.co.uk/london-hotel-chains.htm
[79] See Sustain (2007) *One Planet Dining* for more details of this case study

Avoiding air freighted fruit reduces food air miles, which have the highest associated CO_2 emissions per unit of food of any mode of transport[80]. The proportion of UK food that is transported by air increased 11% in 2006[81].
Sourcing ingredients from street markets cuts out the energy used on lighting and space heating in retail outlets.
Restaurant sites were chosen because of the volumes of people walking past each day; with most customers arriving on foot, customer transport emissions are close to zero.

Table 4.13 GHG increase factors related to small independent restaurant sourcing policy
Using smaller vans and more suppliers may increase food miles and/or GHGs.
Cooking food from scratch may mean that the restaurant itself uses more energy than if it reheated processed food (although there is some evidence that processed food generally uses more energy over its full lifecycle than a freshly made equivalent)[82].

Example 2 – Global Chain

- 635 restaurants across the UK (84 listings on yell.com for London);
- Food, beverages and 'disposables' supplied by '3663', which supplies one quarter of all Britain's catering needs[83]
- '3663' supplies processed and unprocessed ingredients

Table 4.14 GHG reduction factors related to the global supply chain model
Centralised distribution of all inputs results in GHG economy of scales in terms of transport.
Economies of scale in heating, lighting and cooking may (compared to the separate energies that would have been generated 'at home') net out at a reduction in GHGs.

Table 4.15 GHG increase factors related to the global supply chain model
There is some evidence to suggest that processed foods use more energy than freshly prepared foods, although the evidence is inconclusive across food groups[84].
This model delivers a significant proportion of its food to customers' homes, potentially leading to an increase in transport GHGs (it depends, as in Section 3, on substitution effects)

[80] Defra (2005). *The validity of food miles as an indicator of sustainable development: Final report*
[81] Defra (2007) Food Transport Indicators to 2006 (Experimental Statistics)
[82] Manchester Business School for Defra (2006) *Environmental Impacts of Food Production and Consumption*
[83] The Independent (2008). *3663: The company that ate Britain*. Available at http://www.independent.co.uk/news/uk/this-britain/3663-the-food-company-that-ate-britain-448238.html
[84] Manchester Business School for Defra (2006) *Environmental Impacts of Food Production and Consumption*

Procuring standardised food from a central supplier may preclude the use of 'local' ingredients, which may in turn increase the food miles associated with the food.

These examples show that different procurement practises give rise to GHGs at different stages of the food chain, with key differences at the transport stage. However, the evidence regarding the relationship between supply chain length and emissions is insufficient to prove that any one system gives rise to fewer emissions than the others, as is the evidence regarding food types and their embodied emissions. A thorough overview of all the evidence is given in the Transport 2000 Trust 'Wise Moves' report, which concludes that shorter, efficient supply chains give rise to fewest transport emissions, and these may be achieved only with due consideration to journey distance, logistical efficiency and local clustering (or proximity of inputs).

4.6 Other issues

In addition to the issues discussed so far – Public Procurement, London's food retail structure, and Hospitality – there is a range of other issues identified by the GLA in their project specification that have some bearing on the GHG consequences of London's food:

- Community initiatives;
- London's food manufacturing SMEs (small and medium sized enterprises);
- Alternative food sources – farmers' markets, allotments, green roofs and the green belt;
- The London 2012 Olympic and Paralympic Games.

Each of these issues is important for perspectives other than the GHG agenda. Community initiatives can help regeneration, reconnection and community development. London's SME food manufacturers provide valuable employment and underpin the vitality of industrial locations such as Park Royal. Farmers' markets are helping to build links between London's consumers and producers in the surrounding regions; allotments provide opportunities for residents to grow their own food, and so on. The London 2012 Olympic and Paralympic Games, clearly, is the world's premier sporting event and is already having a wide range of impacts on London.

From a GHG point of view, and bearing in mind the 8 billion meals that are eaten in London each year, each issue, taken in isolation, represents a relatively small part of the food system, and therefore has a low impact on the GHG emissions arising from the system over the course of a year. However, these issues interconnect and, taken together, may have a part to play in reducing the emissions of London's food system in the longer term.

For example, since the 'alternative' food sources represented by London's green belt, farmers' markets, green roofs and allotments are typically associated with local, seasonal produce, and since research suggests that this type of food generally has lower embodied emissions, increasing and utilising the supply could help reduce the emissions of London's food system. At a local level, there is potential for these alternative sources to strengthen and forge new links to community initiatives and to reduce some households' food-related emissions. At the London level, alternative sources may have the potential to meet a portion of the demand associated with the London 2012 Olympic and Paralympic Games and with London's food manufacturers.

Community initiatives

A precise 'count' of community initiatives is not readily available, not least because such initiatives vary considerably in nature and scope. They can include healthy eating awareness raising schemes at the neighbourhood level, social enterprises providing fresh produce in areas designated as 'food deserts' and food-growing schemes to support mental health projects. Even this sketch immediately illustrates a second problem: the kinds of GHG impacts from an awareness-raising scheme will clearly be very different from (for example) a scheme that delivers fresh fruit to disadvantaged communities.

For the sake of illustration, however, let us suppose that each London borough has 20 community food projects [probably an over-estimate] each of which has 30 beneficiaries, each of whom is receiving, as a result of the project, the equivalent of one meal a week. This would equate to just over 1 million meals per year – that is, around half a week's worth of the meals delivered just by London's schools and hospitals.

Although this is a small number in the context of London's entire food system, in some boroughs, community initiatives may represent an opportunity to reduce that borough or community's food related emissions by building supply links to alternative food sources, such as local agricultural and horticultural producers, whose products may have lower embodied emissions due to lower transport and storage requirements.

Local initiatives may also have a part to play in general awareness raising among consumers about the environmental impact of their food choices, which could have an effect on some households' emissions.

Farmers' markets

As with community initiatives, a precise means of scaling the contribution of farmers' markets is not straightforward. However, an illustrative metric takes the form: if there are 27 farmers' markets (official and unofficial) in London, each with 500 customers per week, each of whom buys the equivalent of 3 meals, then the total meals per year is around 2 million. As with the above comparison, this represents around one week's worth of schools' & hospitals' meals.

Again, food from farmers' markets is more likely to be local and seasonal, and so may have lower embodied emissions, depending on production techniques and logistical efficiencies. The demand that farmers' markets are able to meet is a function of, among other factors, the land available for agricultural activity around London. However, evidence suggests that there is scope to strengthen supply chain links between London's local producers and London markets, and that farmers are keen to explore new sources of demand for their produce[85]. As well as the wider benefits for the sustainability of the food system, this has the potential to influence the GHGs of a portion of the supply of London's primary produce.

Allotments

It is estimated that there are 36,000 allotments in London. Converting the role of these allotments into 'meal equivalents' is, inevitably, as much a matter of judgment as it is of hard data, a process compounded by the fact that few allotments will be capable of providing entire meals. If the average allotment provides the equivalent of one meal per week throughout the year, then the annual figure would be around 2 million, similar to the impact of farmers' markets.

The small scale of allotment activity suggests that this form of food production is unlikely to have much impact on the demand for supermarket food overall in London. In addition to being small scale,

[85] GLA Economics (2006). *Farming in London's Green Belt*.

allotment produce is likely to complement traditional shopping, rather than substitute for it, so this activity is also unlikely to have any significant effect on food shopping emissions, and may even increase transport emissions, depending on how people travel to their allotments.

However, London once had a strong market garden sector, although planning decisions and developments such as Heathrow airport have steadily reduced the land available for growing fresh produce[86]. In theory, city gardens can provide large amounts of food – in the tropical climate of Havana, Cuba, 200 gardens provide 90% of the city's fresh fruit and vegetables[87]. It would be unrealistic to think that this sector could ever meet London's complex and sophisticated demand for fresh fruit and vegetables; however, it may be possible that, in conjunction with other factors, such as London's green belt land and green roofs, allotments could provide an alternative source of some food types for a small proportion of London's population at certain times of the year, and reduce food-related emissions for some households and communities.

Green roofs

There is an absence of data on the number of green roofs in London, much less the number that might support the growing of food. In our judgment, the contribution of green roofs, in both food volume and GHG terms, is likely to be extremely small. However, green roofs, as suggested in the Mayor's Food Strategy for London, may have a part to play in reducing GHG emissions for a small number of households.

Green belt

The role of London's green belt, in terms of London's food system, has been highlighted in the Mayor's Food Strategy, and is linked principally to the scale of agricultural production within the city's legislative boundaries. With an economic value (GVA) of £63mn, London's agricultural output represents just over two days' worth of Londoners consumer spending on food (of ~£9bn per year).

However, the potential to utilise this resource is worth consideration; as discussed above, there are links to other elements of the food system.

[86] London Assembly (2006). *A lot to lose: London's disappearing allotments*.
[87] Independent (2006). *The good life in Havana: Cuba's green revolution*. http://www.independent.co.uk/news/world/americas/the-good-life-in-havana-cubas-green-revolution-410930.html

There may be untapped potential markets for local primary producers existing within London, some small – such as community initiatives – and some larger – for example, the public sector. Seasonal food grown around the city can reduce journey distance, decrease the requirement for cold storage and avoid the energy inputs that are required for production of non-seasonal and/or indigenous foods, such as polytunnels and heated greenhouses. These factors are beneficial from a GHG perspective as well as having wider implications for the sustainability of London's food system[88].

London's food manufacturing SMEs

Food manufacturing in London accounts for less than one per cent of employment in the capital. The "production" data presented earlier in this report shows the relative size of manufacturing's contribution to food-related GHGs; of this total, less than 10% is actually arising from manufacturing based in the capital; and, of this, the great majority is accounted for by just a small number of large enterprises (such as Tate & Lyle and Allied Bakeries). The GHG contribution of London's food-related SMEs is, thus, very small.

London 2012 Olympic and Paralympic Games

As a global event, there is no doubt that the London 2012 Olympic and Paralympic Games are associated with some very large numbers, whether in terms of the number of journalists that cover the event, the sums of money spent on facilities or the air miles generated in transporting participants and spectators. In narrow 'food' terms, Sustain's work suggests that 1.4 million meals will be served to construction workers between now and the opening ceremony; and 14 million meals will be served during the 60 days of the actual event[89]. In the round, as many as 1.3bn meals will be eaten in the rest of London during the event – i.e. it represents around a one per cent increase in food consumption for two months.

In pursuit of the 'most sustainable games ever', the London Olympic bid explicitly pledged to support consumption of local, organic and seasonal produce, which is likely to have an impact on the GHG profile of the London 2012 Olympic and Paralympic Games. There is also the Olympic legacy to consider; with 40,000 new homes planned as part of a

[88] For more details on seasonal food, see National Consumer Council (2006), *Seasons' Promise: An enjoyable way to tackle climate change*, by Sue Dibb, Joanna Collins and Ed Mayo. http://www.ncc.org.uk/nccpdf/poldocs/NCC133_seasons_promise.pdf

[89] Sustain, NEF and the Soil Association (2007). *Feeding the Olympics: How and why the food London 2012 should be local, organic and ethical.*

regeneration programme, there are opportunities to incorporate a sustainable local food infrastructure. For example, drawing on an example earlier in this report, it is clear how planning decisions can affect the GHG profile of food shops by encouraging or discouraging car use.

Two of the key sponsors of the London 2012 Olympic and Paralympic Games are McDonalds and Coca Cola, whose standardised food products may mean increased GHG emissions from transport due to the reduced scope to include local ingredients (see Section 4 of this report for a discussion of the GHG consequences of different food supply chains). Also, McDonalds products are heavily based on animal proteins, which are relatively high in embodied GHGs. McDonalds and Coca Cola have extensive rights at the event; however, the London Organising Committee of the Olympic Games (LOCOG) and the Olympic Delivery Authority (ODA) are committed to the sustainability of food for the London 2012 Olympic and Paralympic Games, of which GHG emissions are an integral part.

There are, of course, different ways in which these various issues impact upon GHGs, both positively and negatively. In the table below, some of these 'in principle' effects are highlighted for illustrative purposes:

Table 4.16 GHG reduction factors related to various issues
Small manufacturers in London are likely to be servicing local markets, implying reduced transport-related emissions.
Farmers' markets rely on locally grown produce, thus reducing emissions associated with transport and storage.
Due to its seasonality, food grown on allotments requires very low energy inputs, thus reducing emissions.
The concentration of food-demand associated with the London 2012 Olympic and Paralympic Games provides an opportunity for GHG 'economies of scale' in terms of transporting food, and may provide the opportunity to utilise London's local food producers, which would further reduce food miles.

Table 4.17 GHG increase factors related to various issues
Small food manufacturing companies are less likely to have invested in modern energy efficient production technologies.
Smaller vehicles are less efficient per kilo of food transported, so the net effect of substitution might be positive.
The internationalized nature of food provision at the London 2012 Olympic and Paralympic Games may mean large volumes of food that have been produced in an energy-intensive fashion in distant locations.

4.7 Closing Remarks

The complexity of London's food system, as set out in the Mayor's Food Strategy, is clearly reflected in the complexity of an analysis of the GHG consequences of that food system.

The quantitative analysis, showing the sheer scale of the tonnages of GHGs associated with that food system, also provides a means of identifying the particular stages of the food chain which have the greatest impacts; and for considering which elements may be more or less amenable to London-specific influence.

The analysis shows that the largest quantities of GHGs associated with London's food system occur mainly outside the city in the primary production, manufacturing and transport stages. This is not to say, however, that these stages cannot be influenced by London-specific policy. These emissions occur as a direct result of the food choices of London's individuals, households and organisations, so changes to consumption patterns and procurement practices within London have the potential to have an impact right across the food chain.

The qualitative analysis considers a number of issues that cut across the food chain, but which might provide more tractable methods of influencing the GHGs arising from that food chain. As with the more formal quantitative work, the qualitative analysis (and the 'softer' scaling data presented) provides some basis for considering options.

Public sector food procurement, the retail sector and the hospitality sector emerge from the qualitative analysis as having particularly large parts to play in London's food system and may provide valuable inroads into addressing the food sector's GHG emissions. A number of other issues, such as farmers' markets, London's greenbelt and allotments, are relatively small when taken in isolation but, taken together, may provide an important community- and household-level focus for reducing the environmental impacts of food.

A more detailed picture of London's food emissions might combine data about the different GHG implications of different food types with the food chain based analysis. Specific product life cycle emissions are excluded from the current analysis because data is not available across all food types, and the existing data is not based on consistent methodologies and assumptions. It is also important to note that life cycle analyses in isolation provide a very partial picture, since the same product can have very different embodied emissions depending on the nature of the food chain it goes through. However, the high level patterns that emerge from existing data do provide another dimension for consideration in the context of actions to address the environmental impact of food.

There is an extensive policy context surrounding food and its environmental impact at both the London and national levels, from the UK Food Industry Sustainability Strategy, to the projects arising from the London Food Strategy and Implementation Plan, such as the London Development Agency's Strengthening London's Commercial Food Waste Supply Chain project and the Local Food Infrastructure project. Going forward, the Mayor also has a responsibility to publish a Climate Change Mitigation and Energy Strategy. The evidence presented in this report feeds into this policy context by providing a deeper understanding of the nature and scale of food's environmental impact, and a firm foundation from which to identify ways to reduce the climate change impacts of London's food.

Appendix 1: Methodology

All figures are in 1,000 tonnes CO_2eq for the base year 2005, unless otherwise specified.

Stage 1: Primary production

Steps

1. Select relevant economic sectors from Environmental Accounts and allocate emissions to the food chain
2. Convert production to consumption
3. Allocate UK consumption emissions to London

Step 1

Primary production of London's food takes place mainly outside the city, so we begin with the UK Environmental Accounts (EA), using EA codes 1 and 3 (agriculture and fishing) as a base.

Assuming that 100% of agriculture and fishing are related to the food chain, this gives us a UK production account for Stage 1 of the food production-consumption chain. Added to this are the energy consumption figures for the two sectors – see pages 63 - 64 of this appendix for details of the calculations.

Table 1.1 Primary production (UK production)

EA code	Sector	Allocate to food chain	CO2	CH4	N2O	HFC	PFC	SF6	Total GHGs
1	Agriculture	100%	6,288	18,292	26,895	10	-	2	51,486
3	Fishing	100%	513	2	5	10	-	0	530

Step 2

To convert production figures into consumption, we exclude exports and include imports. To do this, we use Food and Agriculture Organisation

(FAO) trade data to calculate UK imports and exports as a proportion of UK production. We then allocate GHG emissions to imports and exports on a pro rata basis, based on the emissions associated with a tonne of UK production.

Table 1.2 Primary production (UK consumption)

Food chain stage	CO2	CH4	N2O	HFC	PFC	SF6	Total
Primary production	8640.98	23243.09	34177.22	25.94	0.00	2.22	66089.45

Assumptions

This approach to allocating emissions to imports and exports does not take into account the diversity of techniques and efficiencies of overseas production systems. However, a lack of reliable and consistent data on overseas primary production means that a linear scaling assumption provides a best estimate. This approach is consistent with the approach of various organisations, including the ONS[i] and WWF[ii].

Neither does this approach distinguish between the composition of imports and exports and the different emissions associated with different food types. The Carbon Trust and BSI are currently developing a standardised methodology for calculating the emissions associated with different products. This methodology may be used in the future to provide more accurate data on imported and exported food and its embodied emissions.

We have based our allocation on tonnage, since this is likely to be a more accurate predictor of embodied emissions than value.

Step 3

We allocate UK consumption to London using ONS mid year population estimates for 2006 to find London's population as a share of UK population.

Table 1.3 Primary production (London consumption)

Food chain stage	Allocate to London	CO2	CH4	N2O	HFC	PFC	SF6	Total
Primary production	12.40%	1,071	2,882	4,238	3	0	0	8,195

Assumptions

Weighting London's population to account for its unique consumption habits was considered as a possibility for obtaining a more accurate estimate of the share of primary production attributable to London. However, we decided to use unweighted population since the Expenditure and Food Survey shows that London's consumption pattern follows roughly the same pattern as that of the UK as a whole.

Factoring in the impact of tourism was also considered. Analysis showed that the tourism balance for London is negative: Londoners spend approximately 123,000 more tourist nights out of London than tourists spend in London. However, since this difference is equivalent to less than 2% of the London population, we did not incorporate this into the calculation.

We do not make explicit the emissions arising from primary production within the administrative boundary of London, since these emissions are captured in the UK figures.

We calculate emission arising from agricultural activities only, so emissions associated with the production of fertilisers used in agriculture are excluded from this analysis.

Stage 2: Manufacturing

Steps

1. Select relevant economic sectors from Environmental Accounts and allocate emissions to the food chain
2. Convert production to consumption
3. Allocate UK consumption emissions to London

Step 1

London's food is manufactured and processed both inside and outside of London, so we begin with UK production emissions. EA code 8 gives emissions arising from food and beverage manufacturing in the UK, of which 100% is related to the food chain. The figures below include energy consumption from that sector.

Table 2.1 Manufacturing (UK production)

EA code	Sector	Allocate to food chain	CO2	CH4	N2O	HFC	PFC	SF6	Total GHGs
8	Food and beverages	100%	10369.58	15.86	90.23	19.90	0.00	0.00	10495.57

Step 2

To convert production figures into consumption, we exclude exports and include imports. To do this, we use HM Revenues and Custom data[iii] to calculate UK imports and exports as a proportion of UK production. We then allocate GHG emissions to imports and exports on a pro rata basis, based on the emissions associated with a unit of value of UK production.

Table 2.2 Manufacturing (UK consumption)

Food chain stage	CO2	CH4	N2O	HFC	PFC	SF6	Total
Manufacturing	22,164	223	172	30	-	17	22606.76

Assumptions

Again, the linear allocation assumption made in order to allocate emissions to imports and exports does not take into account the diversity of overseas production processes or the composition of imports or exports.

Step 3

We allocate UK consumption to London using ONS mid year population estimates (2006) to find London's population as a share of UK population.

Table 2.3 Manufacturing (London consumption)

Food chain stage	Allocate to London	CO2	CH4	N2O	HFC	PFC	SF6	Total
Manufacturing	12.40%	2,748	28	21	4	0	2	2,803

Assumptions

London based food manufacturing emissions are captured within the UK production figures in Step 1, so we do not make explicit the emissions arising from London based manufacturing. Note: based on value, London accounts for 9% of UK food and beverage manufacturing.

Stage 3: Transport, storage and distribution

Steps

1. Use DEFRA 'food miles' CO_2 data
2. Exclude emissions from car travel and supermarket GHGs to avoid double counting
3. Estimate other transport GHGs
4. Calculate storage figures from EA code 71
5. Add transport and storage figures together
6. Allocate emissions to London

Step 1

DEFRA calculates the carbon dioxide emissions related to food transport in the UK. This figure includes transport related to food imports, and excludes the overseas portion of transport related to exports[iv]. We use this figure as an estimate for UK food transport consumption.

Table 3.1 Food transport (UK consumption – CO2 only)

CO_2 emissions from food transport	17,948

Step 2

This figure includes all food related transport, including private car use. We include private car use as a separate stage of the food production-consumption chain, so we must exclude it here.
DEFRA estimates that cars account for 21% of total emissions from food transport.

To avoid double counting, we also exclude supermarket HGVs, since these are included in EA code 61 (Retail).

Table 3.2 Commercial food transport (UK consumption – CO2 only)

CO_2 emissions from cars (21% of total[v])	3,769
CO_2 emissions from supermarket owned HGVs (25% of HGV transport[vi])	1,167

CO_2 emissions of food transport, excl cars	13,013

Step 3

To get a fuller picture, we estimate the other GHGs associated with food transport. To do this, we calculate the proportions of other GHGs associated with a tonne of CO_2 for each mode of transport from the Environmental Accounts.

Table 3.3 Commercial food transport (UK consumptions – all GHGs)

GHG	CO2	CH4	N2O	HFC	PFC	SF6	Total
All food transport	13,013	12	152	75	-	-	13,252

Step 4

Storage (food warehouses and distribution centres) is captured in EA code 71 – auxiliary transport activities. To find the proportion of this sector that is food related, we use the proportion of road freight that is food related (27%[vii]) as an estimate. This figure also includes the sector's energy consumption allocated to food storage. Since storage is a service, rather than a tradable product, the EA figures represent emissions from use (or consumption) of this service.

Table 3.4 Food storage (UK consumption)

EA code	Sector	Allocate to food chain	CO2	CH4	N2O	HFC	PFC	SF6	Total GHGs
71	Auxiliary transport activities	26.77%	366	3	25	7	-	0	402

Adding the storage emissions to the transport emissions gives total figures for UK food transport, distribution and storage.

Table 3.5 Food transport, storage and distribution (UK consumption)

Food chain stage	CO2	CH4	N2O	HFC	PFC	SF6	Total
Transport, storage	13,834						14124.49

and distribution		26	180	83	-	1	

Step 5

To allocate transport and storage emissions to London, we assume that the services are directly connected to the retail and hospitality sectors, and so take the value of these two sectors in London (food-related share only) as a share of the UK sectors.

Table 3.6 Transport, storage and distribution (London consumption)

Food chain stage	Allocate to London	CO2	CH4	N2O	HFC	PFC	SF6	Total
Transport, storage and distribution	25.17%	3,482	7	45	21	0	0	3,555

Stage 4: Retail

Steps

1. Select relevant economic sectors from Environmental Accounts and allocate emissions to food chain
2. Allocate UK consumption emissions to London

Step 1

EA code 61 gives the GHGs arising from the retail and repair industry. The first step is to calculate what proportion of these GHGs are related to food retail. Using the Annual Business Inquiry[viii], we calculate that food and beverage retail accounts for 33.05% of the retail sector, by value. The Annual Business Inquiry is based on the Standard Industrial Classification (SIC) 2003, and division 52 (Retail and Repair) corresponds directly to EA code 61[ix]. The table below includes energy consumption for the sector.

Because retail is a non-tradable service, the EA code gives emissions arising from use (consumption) of this service.

Table 4.1 Retail (UK consumption)

EA code	Sector	Allocate to food chain	CO2	CH4	N2O	HFC	PFC	SF6	Total GHGs
61	Retail and repair	33.05%	1777.72	2.72	45.65	834.08	0.00	0.00	2660.17

Step 2

Retail is the first stage of London's food production-consumption chain to be confined to the city's boundary. We therefore use London-specific data to allocate UK emissions. We use Annual Business Inquiry data on the value of London's retail sector[x] and apportion emissions to London based on the city's food retailing activities as a share of the UK food retailing sector.

Table 4.2 Retail (London consumption)

Food chain stage	Allocate to London	CO2	CH4	N2O	HFC	PFC	SF6	Total GHGs
Retail	19.63%	526	5	10	164	0	0	706

Assumptions

We use the UK share of food retailing of total retailing as an estimate for London in the absence of Government Office level four-digit data for division 61 in the Annual Business Inquiry.

Stage 5: Purchasing

We define 'purchasing' as consumer travel to buy food. The Environmental Accounts do not cover domestic transport, so we use Department for Transport data on personal travel.

Steps

1. Find food shopping as proportion of total shopping
2. Calculate London's food shopping miles
3. Disaggregate food shopping miles by mode of transport
4. Convert food miles to emissions

Step 1

The Department for Transport provides data on average number of trips per year for shopping, disaggregated for food shopping.[xi] This allows us to calculate what proportion of shopping trips are food shopping trips.

Table 5.1 Shopping trips 2002 -2003, all modes of transport (UK)

Type	**Trips pppy**	**Av trip length (miles)**
Food shopping	90.52	2.32
Non-food shopping	106.46	5.63
All shopping	196.97	3.73
Food shopping as % of all shopping		**45.95%**
Food shopping miles as % of total shopping miles		**62.27%**

Step 2

To calculate London's food shopping miles, we use a variety of data sources.

Table 5.2 Food shopping trips (London)

London		**Source**
Average length of trip to supermarket (miles)	2.52	YouGov survey 2007[xii]
Av no. of shopping trips pppy	178.00	DfT London Personal Travel 2003[xiii]
Number of food shopping trips pppy	81.80	Calculated using proportion of food shopping found in Step 1

Average number of food shopping miles pppy	206.13	Trip length x no. trips
London total food shopping miles (all modes)	**1.55 x 10^9**	Av food miles pppy x population

We calculate that the average number of food shopping trips made by Londoners is 82 per person per year. This is lower than the UK average of 90 (see table 2.5.1 above). This pattern – Londoners making fewer food shopping trips per year than the UK average, is confirmed by DfT's regional personal travel data, which show that Londoners make 178 shopping trips per year, compared with a GB average of 213[xiv].

Assumptions

We use 2007 trip length data because this is the best London-specific source available.

We use 2003 personal travel data as an estimate for our base year as London's transport emissions have remained flat since 1990[xv].

We use the UK proportion of food shopping trips of total shopping trips as an estimate for London.

Step 3

In order to accurately calculate the emissions arising from London's food purchasing miles, we consider the differential emissions associated with different modes of transport and the different patterns of travel in the capital.

Table 5.3 London food purchasing miles by mode

Mode	**% of food shopping trips**	**Miles (millions)**
Walk	**27.09%**	419.48
Car/van driver	**27.61%**	427.54
Car/van passenger	**16.19%**	250.70
Other private	**2.88%**	44.56
Local bus	**13.55%**	209.84
Other public	**12.68%**	196.41
All modes	**100%**	1548.53

Total car / van / driver / passenger / other private	**722.80014**
Total public transport	**406.251973**

Assumptions

Although data is available for UK patterns of food shopping transport, analysis indicates that food shopping transport patterns roughly follow overall trip transport patterns. London has significantly different personal transport patterns, so we use London's overall trip transport pattern as an estimate of food shopping patterns.

Step 4

Food miles are converted to emissions using DEFRA's conversion factors[xvi]

.

Table 5.4 London's CO2 emissions (1000 tonnes) from food purchasing

Mode	**Assumption**	**Total CO2**
Private transport - car/van	Average car (unknown fuel)	226.53
Private transport - other	Average petrol motorbike (unknown size)	7.66
Public transport - bus	Bus	19.99
Public transport - other	Underground	11.04
Total CO2 from all food shopping transport		**265.22**

DEFRA estimates that food purchasing miles in the UK give rise to 2,392,000 tonnes of CO2[xvii]. If we apportion London a share of this based on population (12.40%), we arrive at a figure of 296,608 tonnes. This is a slightly larger figure than our estimate of 265,219 tonnes. We would expect this, given London's unique transport patterns, and, in particular, lower use of the car for food shopping (according to DfT, 35% of Londoners do not have a car, compared to 24% for England)[xviii].

Assumptions

We remove walking to the shops since we assume zero emissions from this mode of transport.

Stage 6: Preparation and storage

This stage of the food production-consumption chain relates to emissions generated by Londoners' preparation and storage of food at home. All data in this section is taken from BERR[xix].

Steps

1. Calculate the share of energy used for domestic cooking and cold storage in the UK
2. Calculate energy used for domestic cooking and cold storage in London and convert to emissions

Step 1

We firstly calculate the proportion of domestic energy that is used for cooking and cold storage in the UK. This data is not available for London.

Table 6.1 Domestic energy use for food preparation and storage (UK)

	1000 toe	**% of total**	
Total domestic energy use	47,161	100%	
Electricity consumption for domestic cold appliances	1,397	2.96%	Total elec: 5.34%
Electricity consumption for domestic cooking	1,120	2.38%	
Gas consumption for domestic cooking	294	0.62%	
% UK domestic energy used for food preparation and storage		**5.96%**	

Step 2

We apply the shares calculated in Step 1 to London's total domestic energy use, accounting for the gas/electricity mix, since these produce different levels of emissions. The final step is to convert energy use into CO2 emissions using DEFRA's conversion factors[xx].

Table 6.2 Domestic energy use for food preparation and storage (London)

Source	**kwh/year.**	**CO_2 (Kt/yr)**
Total domestic energy use in London	66856200000	
Electricity for cooking and cold storage	3568113977	1878.86
Gas for cooking	416164625.1	85.73

Total CO2 from London domestic food preparation and storage	**1964.59**

Assumptions

We assume that London uses the same proportion of domestic energy consumption on food preparation and storage as rest of UK. Detailed data on London's energy consumption by domestic end use would improve this estimate.

NOTE: These figures only include energy consumption: they do not capture other GHGs arising from refrigeration. HFCs are a common refrigerant used in domestic refrigeration appliances, which typically contain around 0.1kg refrigerant[xxi]. Therefore, these figures represent an underestimate of the total GHG impact of domestic cold storage. However, it is only a slight underestimate, since energy use accounts for 96% of emissions[xxii].

Stage 7: Consumption

Stage 7 relates to the emissions arising from food and beverage consumption outside the home in London. We use the definition of the foodservice provided by market analysts Horizon (Foodservice Intelligence)[xxiii], which comprises restaurants, quick service (fast food, café, takeaway), pubs, hotels, leisure, staff catering, health care, education and services (government, welfare).

Steps

1. Select relevant economic sectors from Environmental Accounts and allocate emissions to the food chain
2. Allocate UK emissions to London

Step 1

EA code 62 gives GHG emissions arising from the hotel and restaurant sector, which also includes catering and canteens. We use the Annual Business Inquiry (ABI)[xxiv] to estimate the proportion of this sector that is food related. The ABI Hotels and Restaurants category (SIC 55) corresponds directly to EA code 62[xxv].

Table 7.1 Foodservice as % of hotels and restaurants sector (UK)

SIC	Description	GVA (£million)
55	Hotels and restaurants	28,511
55.3	Restaurants	8,885
55.4	Bars	8,370
55.5	Canteens and catering	3,639
Foodservice as % of UK hotels and restaurants sector		**73.28%**

This allows us to allocate total sector emissions to the food chain.

Table 7.2 Consumption (UK)

EA code	Sector	Allocate to food	CO2	CH4	N2O	HFC	PFC	SF6	Total GHGs

		chain							
62	Hotels and restaurants	73.28%	3098.60	43.28	35.20	74.07	0.00	3.43	3254.57

Assumptions

We use sector value to estimate emissions. Since GVA is consistent with the Environmental Accounts, this gives us an internally consistent estimate, but is necessarily oversimplified. However, in the absence of lifecycle analyses of products, this gives the best estimate.

Hotel food is omitted from the analysis due to a lack of data on how emissions from hotels are produced (what proportion comes from food?).

Also excluded is in-house catering within organisations – catering that is not contracted out, since this is not counted in this sector in the national accounts.

These factors suggest that our figure is an underestimate.

Step 2

Since half of all restaurants are in London, allocating UK emissions to the capital on a per capita basis would be a potentially significant underestimate. We therefore apportion the emissions by the value of the sector in London, again using the ABI.

The London hotel and restaurant sector accounts for 23.34% of the total UK sector.

Table 7.3 Consumption (London)

Food chain stage	Allocate to London	CO2	CH4	N2O	HFC	PFC	SF6	Total GHGs

Consumption	23.34%	723	10	8	17	0	1	760

Assumptions

Travel to restaurants is omitted in this analysis since we were unable to disaggregate travel data for 'entertainment and sports.' These figures are therefore likely to be an underestimate.

Stage 8: Disposal

Steps

1. Calculate municipal and commercial waste arisings
2. Calculate municipal and industrial waste by treatment method
3. Estimate the share of this waste that is food-related
4. Calculate share of food waste that is not recycled/composted
5. Allocate waste to London

Step 1

Using data from DEFRA and the Environment Agency, we calculate municipal and commercial/industrial waste arisings in London, England and the UK.

This figure excludes agricultural, mining, quarrying sludge and recycled and re-used C&D waste.

Table 8.1 Total waste arisings

	Quantity ('000 tonnes)
London	12,123
England	106,491
UK	126,534

Step 2

The method of disposal of waste influences the emissions that arise.

Assumptions

For municipal waste, it is assumed that the UK treats its waste in the same way as England; for C&I waste, it is assumed that London and the UK have the same methods of disposal as England.

Table 8.2 Methods of waste disposal

Municipal waste 2002/03 (%)						
	Landfill	Incineration without EfW	Recycled / Composted	Other	RDF manufacture	Incineration with EfW

London	71	0	9	0	0	20
England	75	0	16	0	0	9
UK	*75*	*0*	*16*	*0*	*0*	*9*
Industrial and Commercial Waste 2002/03 (%)						
London	44	3	45	4	0	3
England	44	3	45	4	0	3
UK	44	3	45	4	0	3

Source: DEFRA

Step 3

Using composition data for municipal waste (Source: Analysis of household waste composition and factors driving waste increases, J. Parfitt, WRAP, 2002) and assuming similar distributions for the UK and London, we calculate the quantity of waste that is food related.

Table 8.3 Share of waste that is food related

Municipal waste - 2002/03 - 000's tonnes					
	can be recycled/composted widely		**cannot be recycled/composted widely**		**Total**
	Food-related waste	**non-food related waste**	**Food-related waste**	**Other Waste**	
London	938	1,660	648	1,201	4,446
England	6,199	10,972	4,285	7,938	29,394
UK	7,486	13,251	5,176	9,587	35,500
Industrial & Commercial waste 2002/03 - 000's tonnes					
	Food-related waste	**non-food related waste**	**Food-related waste**	**Other Waste**	
London	726	N/A	336	N/A	7,507
England	6,189	N/A	3,147	N/A	7,907
UK	7,291	N/A	3,708	N/A	80,000

Step 4

We then calculate the amounts of the different types of waste that are recycled.

Table 8.4 Total waste not recycled ('000 tonnes)

Municipal			
	Food-related waste	**Non-food related waste**	**Total**
London	1,441	2,605	4,046
England	8,786	15,905	24,691
UK	10,611	19,209	29,820
Commercial and industrial			
London	734	3,376	4,109
England	3,388	33,786	37,174
UK	3,991	39,802	43,793

Step 5

The next step is to calculate how this non-recycled waste is treated. It is assumed that waste disposal options for food waste are similar to those for total waste. This is not true as food waste is more likely to be composted and food packaging, recycled, for example. However, there is no data available on how food-related waste is disposed of.

Table 8.5 Methods of treatment of non-recycled food related waste

Municipal		
	Landfill	**Incineration with EfW**
London	1,125	317
England	7,845	941
UK	9,474	1,137
Commercial and industrial		
London	692	42
England	3,195	193
UK	3,763	228

Step 6

Next we calculate food waste as a share of solid waste.

Table 8.6 Food related waste as share of solid waste

	Food-related waste as a % of solid waste
London	25%
England	17%
UK	17%

Step 7

By applying this share to the UK solid waste emissions, we find emissions from London's food waste.

Table 8.7 Emissions from food related waste

	CO2	**CH4**	**N2O**	**HFC**	**PFC**	**SF6**	**Total**
Food-related waste in the UK	140	3,244	2	3	-	53	3,443
Food-related waste in London	19	448	0	0		7	476

Emissions from recycling/composting food waste or energy recovery are not included here. This is because even though the recycling of waste produces some emissions, some of these are offset by the reduction in fossil fuels that would be required to obtain new raw materials. It is beyond the scope of this project to find out the carbon balance of the recycling of food-related waste.

Energy consumption allocated to food chain stages

In the Environmental Accounts, gas and electricity consumption is measured at the production source – i.e. it is allocated to the companies that produce it, rather than end users. We use this data and other fuel use data from the environmental accounts to estimate the amount of energy used at each stage of the food chain. These figures were added in at the first stage of calculation for each sector, before emissions were allocated to the food chain.

The proportion of total gas and electricity that each sector is responsible for was calculated from Environmental Accounts table Carbon use by fuel type by 93 economic sectors.

EA code	Economic sector	% of total electricity and gas consumption	CO2	CH4	N2O	HFC	PFC	SF6	Total GHGs
51-56	Electricity and gas		180,858	4,773	1,074	49	-	413	187,167
1	Agriculture	0.39	699	18	4	0	-	2	723
3	Fishing	0.04	67	2	0	0	-	0	69
8	Food and drink	3.00	5,424	143	32	1	-	12	5,613
61	Retail	1.51	2,733	72	16	1	-	6	2,828
62	Hotels, catering, pubs etc	1.13	2,052	54	12	1	-	5	2,124
71	Ancillary transport services	0.19	343	9	2	0	-	1	355
63	Railway transport	0.10	174	5	1	0	-	0	180
60	Wholesale distribution	0.85	1,537	41	9	0	-	4	1,590

68	Road freight	0.54	982	26	6	0	-	2	1,016
69	Water transport	0.02	39	1	0	0	-	0	40
70	Air transport	0.07	125	3	1	0	-	0	129

Appendix 2: Methodological notes

Overview of the Environmental Accounts (EA)

- We use EA on a 93 sector level for all calculations, except where specified.
- The main data source for the EA is National Atmospheric Emissions Inventory (AEA Energy and Environment, formally Netcen)
- Emissions are calculated by multiplying fuel consumption by emissions factors and adding other emissions not related to fuel consumption, such as nitrous oxide from agricultural processes and methane from landfill.
- Emissions are allocated to sectors using a variety of data sources, such as Input-Output supply and use tables, Defra and DfT statistics[xxvi].
- Since the EA is compiled on a National Accounts basis, this enables us to use standard measures such as GVA in our calculations, which provides a consistent calculation framework.
- GVA measures the contribution to the economy of specific producers, sectors or industries. All figures are in basic prices.
- The environmental accounts estimate emissions on a different basis to the Kyoto Protocol (on which Defra figures are largely based), which only measures emissions from UK territory. The EA are compiled on a National Accounts (or 'residents') basis, which means they include UK companies' and households' travel and transport activities abroad and excludes non-residents' travel and transport within the UK.
- In this study, which focuses on consumption-related emissions, we address these points by allocating emissions to imports and exports at relevant stages of the food production-consumption chain, then excluding exports and including imports to give domestic consumption figures.

Allocating emissions to imports and exports

- Using GVA, we endogenise trade: we allocate the environmental impacts of production on a pro rata basis to imports and exports and thereby allocate responsibility for embedded emissions to the consumption of the population living in our chosen area.
- This approach provides a consistent calculation framework, but the linear allocation of environmental impacts assumes that imports have identical environmental impacts to domestic production so disregards efficiency and therefore impact variations in production systems. We assume that imports have the same emissions impacts regardless of the import mix. However, until reliable data for overseas production exist, this is the most reliable way to estimate environmental impacts of domestic consumption. The additional impacts of imports in terms of transport emissions are included in Section 3 of this report (Stage 3). To account for the import mix would require life cycle analyses of all the individual products, which are not available.
- Other approaches to calculating the impacts of imports would be to use other countries' EA (only exist for very small number of countries /unavailable) or other countries' fuel use (inconsistent and only CO2). Therefore, assuming that emissions are constant per unit of GVA provides the best estimate at this time. In the future, when Environmental Accounts are compiled to international standards in more of our trading partners, this estimate will be much more accurate. The ONS provides a more detailed summary of the work that is required to improve these estimates[xxvii].

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