Waltham Forest Carbon Footprint

FINAL REPORT

Prepared September 2007

Executive summary

SEA/RENUE has been commissioned by the London Borough of Waltham Forest to conduct a carbon footprinting study in two parts: an estimation of the current footprint and the development of a tool to calculate the footprint in future years.

The carbon footprint of the council includes the following elements:

- CO_2 emissions from the use of fuel and electricity in council owned or operated buildings and street lighting
- CO_2 emissions from the use of fuel in power generation in council owned or operated buildings (such as renewables or CHP) and CO_2 displaced by power production
- Emissions from buildings, transport or waste for contractors or partners undertaking work on behalf of the borough such as the waste management contractor. The methodology for this would be the same as for the council itself
- CO_2 emissions from the use of fuel in the councils vehicle fleet
- CO_2 emissions from staff travel for work purposes (but not using the council fleet, e.g. in private cars or by public transport)
- CO_2 emissions from staff travel for commuting to and from work.
- Greenhouse gas (GHG) emissions (mainly methane - CH_4 and carbon dioxide - CO_2) associated with waste management for waste produced by the council itself and waste collected in the borough by the council.

Results

The results of the carbon footprinting study are shown in Table 1 and Figure 1 below. The total footprint for the council is estimated to be **40,704 tonnes per year**. This equates to approximately 3.5% to 4% of the total emissions from all sectors within the borough boundary.

Emissions source	CO_2 Emissions (tonnes/year)	CO_2 Emissions (%)
Energy consumption	33,368	82%
Fleet fuel consumption	5,283	13%
Staff commute	4,459	11%
Travel for work	209	1%
Energy generation	-2,615	-6%
Total	**40,704**	**100%**

Table 1 Total emissions for 2006 – 2007

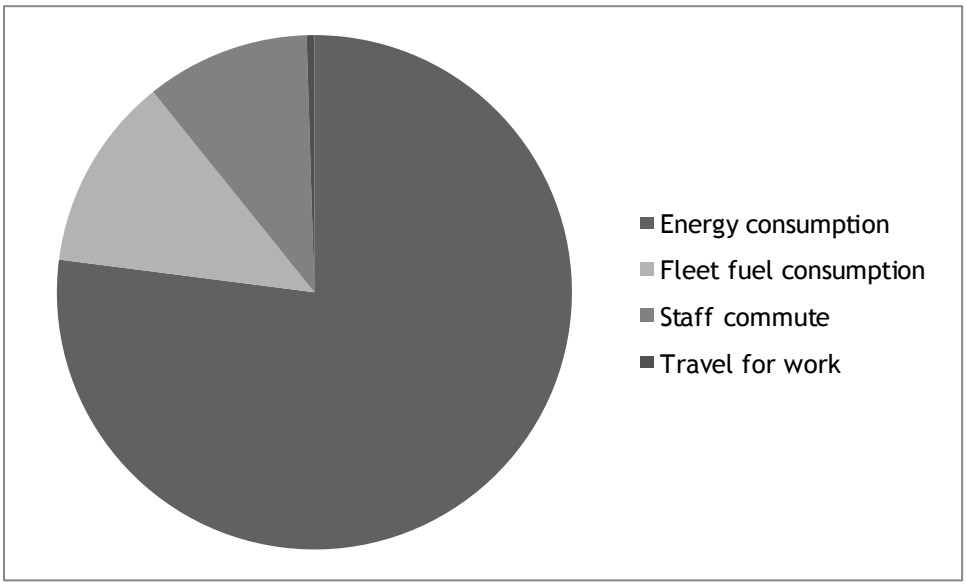

Figure 1 Total emissions for 2006 – 2007, excluding energy generation

In line with proposed LA indicators, emissions associated with waste management are excluded from the total footprint. However these emissions have been estimated in this report and found to generate a net reduction of 6,642 tpa due to energy saved through recycling and incineration. Including waste management would result in a footprint of 34,062 tpa.

Recommendations

A key outcome of this work is a series of recommendations that will enable more accurate monitoring of energy use and CO_2 emissions in the future in combination with the use of the footprinting tool. These recommendations include:

- Use the list of buildings operated by LB Waltham Forest and its contractors to report annual energy consumption for each building from billing information. This could also result in improved billing accuracy by reducing the use of estimated meter readings.
- When specifying contracts for statutory services, annual energy consumption reporting could be required from contractors for buildings and fleet vehicles.
- When reporting a building's electricity consumption, it should be noted whether the bill is a green tariff exempt from the Climate Change Levy (CCL).
- When mileage claims are made for travel for work, record more details of the vehicle, such as engine size and/or VED band, fuel type, mileage and car make.
- Record motorcycle mileage claims separately to car mileage.
- Record public transport, taxi use and flights for work via expenses.
- When carrying out staff commuting surveys, break down responses featuring public transport or combinations of modes more accurately and record more precise distances.
- Record fuel use or mileage for courier and delivery companies by type of vehicle.
- Maintain a list of renewables and CHP installations at their own sites and in the borough as a whole.

Wider community emissions

There are several datasets available to assess the total CO_2 emissions from within the borough boundary. These include emissions from dwellings, non domestic buildings and transport in addition to those arising from council activities.

The two most useful ones are the most recent Defra figures (from 2004) and a modified version of the GLA LECI figures (from 2003), as shown in Table 2 below.

Waltham Forest has the 7th lowest overall emissions compared of the 33 London Boroughs, the 4th lowest total emissions per capita and the 17th lowest domestic emissions per capita (see Appendix 11).

Per capita domestic emissions are approximately 2.4 tonnes per person per annum while overall emissions per capita are in the region of 5 tonnes per person per annum.

Model / CO_2 emissions ktpa	Domestic	Commercial & Industrial (C & I)	Transport	Total
LECI 2003 (modified)	514 (51%)	274 (28%)	205 (21%)	994
Defra 2004	529 (46%)	312 (27%)	306 (27%)	1147

Table 2 Wider community emissions estimates

The neighbourhoods with the most concentrated emissions are located in the south and centre of the borough, corresponding to higher building densities. However domestic emissions per capita and per household are higher in the north of the borough. This could be due to a number of factors including building size, building efficiency and affluence of the residents.

In addition, emissions are projected to grow by a further **16,780** tonnes CO_2 per annum by 2016 due to new building to accommodate an increased population and workforce. This growth is expected to come from new domestic buildings, an increase in transport emissions due to an increased population and a small decrease in emissions is projected due to a reduction in industrial floorspace. This growth represents approximately 1.5% of the current emissions total.

Reducing the carbon footprint

Calculating the baseline emissions for the borough is a crucial first step in the process of reducing CO_2 emissions in order to reduce LB Waltham Forest's contribution to climate change, and is essential in order to measure progress.

This report attempts only to quantify current emissions. It does not make recommendations for reducing emissions, as this will follow in a separate climate change strategy.

Clearly energy use in buildings must be targeted in order to reduce the footprint of the council's activities. Reducing this by 20%, for example, would result in a reduction of more than the combined transport emissions total. Gathering individual consumption data for each building will enable more effective targeting of this sector.

In terms of transport, staff commuting is the dominant source of emissions. This is already being addressed through travel planning exercises and these should continue and expand.

For emissions from the wider community in Waltham Forest, around half of emissions come from energy use in domestic buildings with the remainder split between transport and non domestic buildings. The greatest source of emissions growth is also projected to come from new domestic buildings, closely followed by transport. Clearly there is a need to target domestic buildings in order to make the biggest impact on CO_2 emissions from the borough as a whole.

Abbreviations/Terms of Reference

ALMO	Arms Length Management Organisation
BERR	Department for Business, Enterprise and Regulatory Reform
BVPIs	Best Value Performance Indicators
C	Carbon
CCAP	[Mayor's] Climate Change Action Plan
CCL	Climate Change Levy
CfSH	Code for Sustainable Homes
CHP	Combined Heat and Power
C & I	Commercial and Industrial
CIBSE	Chartered Institute of Building Services Engineers
CO_2	Carbon Dioxide
CO_2 eq.	Carbon Dioxide Equivalent
CH_4	Methane
Defra	Department for Environment, Food and Rural Affairs
DTI	Department of Trade and Industry
EU	European Union
gCO_2	Grams of CO_2
GHG	Greenhouse Gas
GIS	Geographical Information System
GLA	Greater London Authority
GWh	Gigawatt hour
ha	Hectare
$kgCO_2$	Kilograms of CO_2
ktpa	Kilotonnes per annum
kW_e	Kilowatts electrical
kWh	Kilowatt-hour
kW_p	Kiliowatts peak
LAs	Local Authorities
LB	London Borough
LBWF	London Borough of Waltham Forest
LECI	London Energy and CO_2 Emissions Inventory
LULUCF	Land Use, Land Use Change and Forestry
m^2	Square metres
MSW	Municipal Solid Waste

MWh	Megawatt hour
NAEI	National Atmospheric Emissions Inventory
ONS	Office of National Statistics
PV	[Solar] Photovoltaic
SOA	Super Output Area
tCO_2	Tonnes of CO_2
TfL	Transport for London
tpa	Tonnes per annum
VED	Vehicle Excise Duty

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1 Introduction

SEA/RENUE has been commissioned by the London Borough of Waltham Forest to conduct a carbon footprinting study in two parts: an estimation of the current footprint and the development of a tool to calculate the footprint in future years.

1.1 Climate change

Climate change is probably the greatest challenge faced by humankind today. The need for action to reduce greenhouse gas emissions is becoming increasingly urgent and local authorities are well placed to encourage this to happen at a local level through setting an example, disseminating information and through policies to encourage emissions reductions. The first step in this process is to understand the current levels of emissions.

1.2 Carbon footprint

The first part of the work is to calculate the current carbon footprint for the borough. This will quantify the following:

- CO_2 emissions from the use of fuel and electricity in council owned or operated buildings and street lighting
- CO_2 emissions from the use of fuel in power generation in council owned or operated buildings (such as renewables or CHP) and CO_2 displaced by power production
- Emissions from buildings, transport or waste for contractors or partners undertaking work on behalf of the borough such as the waste management contractor. The methodology for this would be the same as for the council itself
- CO_2 emissions from the use of fuel in the councils vehicle fleet
- CO_2 emissions from staff travel for work purposes (but not using the council fleet, e.g. in private cars or by public transport)
- CO_2 emissions from staff travel for commuting to and from work.
- Greenhouse gas (GHG) emissions (mainly methane - CH_4 and carbon dioxide - CO_2) associated with waste management for waste produced by the council itself and waste collected in the borough by the council.
- All emissions from within the borough boundary
- An estimate of projected future emissions from new buildings.

This document describes the methodology and the results of this study.

1.3 Footprinting tool

In addition to estimating the current footprint, a further aim of this work is to develop a software tool to calculate the carbon footprint of the council's activities. This tool will enable LB Waltham Forest to calculate its footprint year on year into the future by updating the data in the software tool.

The two parts of the work have been carried out side by side, so the software tool uses the methodology and provides the results described here.

A companion document describes the design of the tool in more detail and provides a user guide.

1.4 Proposed Defra Indicators

Defra has proposed two climate change mitigation Best Value Performance Indicators (BVPIs) for local authorities. These are subject to an informal consultation and have not been formally adopted. However, it is considered likely that these indicators will be adopted and therefore this study aims to quantify emissions

in line with Defra methodologies so that LB Waltham Forest will be well placed to report on climate change performance indicators in the future.

The indicators are:

1. **Percentage CO_2 reduction in the local authority's own operations**. This reflects the direct role of LAs in reducing carbon emissions from their own operations through more efficient energy use, installing renewable energy systems and improving vehicle efficiency. We propose that this would include the delivery of contracted out services such as leisure and waste services.
2. **Percentage CO_2 reduction per capita in the community.** This reflects the role of LAs leading and acting as an exemplar within communities to reduce carbon emissions via their service delivery and community leadership role. This includes emissions from housing, local business and public sector organisations, community organisations and local transport. Action by Local Strategic Partnerships led by local authorities, should take joint accountability for initiatives to drive CO_2 reduction in the community.

It is proposed that the second indicator will use centrally collected Defra statistics on local authority CO_2 emissions. The most recent of these are described in Sections 5.2 and 9.3.

The proposed methodology to calculate the carbon footprint for the first indicator is not clearly defined. The main area of uncertainty here is the choice of emissions factors, described in more detail later.

2 Recommendations for data collection

This section outlines recommendations that LB Waltham Forest might like to consider in order to improve the collection of data for future updates of the carbon footprinting calculations. These recommendations are provided by SEA/RENUE and do not commit LB Waltham Forest to any particular course of action.

It is recognised that this is a relatively new area of work for Waltham Forest (and most local authorities nationwide) and that existing systems cannot be expected to be set up to facilitate carbon footprint reporting. The implementation of these recommendations will depend on a number of factors including integration with existing systems, compatibility with other work streams and cost. Therefore not all of these recommendations will be practicable at this time. However their implementation would improve the accuracy of the carbon footprint estimation and it would be worth checking against this list periodically when updated calculations are made and particularly when systems within the council are changed.

2.1 General

It is recommended that LB Waltham Forest set up systems and allocate sufficient resources to start off and maintain carbon footprint reporting in line with the recommendations outlined here.

2.2 Buildings

The key recommendation for the buildings energy consumption is to use the list of buildings operated by LB Waltham Forest and its contractors to report annual energy consumption for each building from billing information. This would provide the most accurate footprint estimate. When specifying contracts for statutory services, annual energy consumption reporting could be required from contractors.

In addition, when reporting a building's electricity consumption, it should be noted whether the bill is a green tariff exempt from the Climate Change Levy (CCL). Defra guidelines (which might be mandatory for the proposed BVPI) would assign zero CO_2 emissions to the consumption from these tariffs.

This would have an added benefit of reducing billing based on estimated readings by encouraging actual readings that can be provided to utility companies.

2.3 Transport

2.3.1 Fleet

- Record information on fuel consumption by contractors. This could be specified in future contracts for work.

2.3.2 Travel for Work

- When mileage claims are made, record more details of the vehicle, including either;
    - Fuel use (this is the most accurate) or,
    - Exact engine size and/or VED band, fuel type, mileage and car make or,
    - Fuel type and mileage (least accurate).
- Record motorcycle mileage claims separately to car mileage as the emissions factors are significantly different.
- Record public transport via expenses, for instance "approximately 3 miles by bus" or "from *x* to *y* by underground", the first will be much simpler to calculate.
- Record taxi use via expenses, mileage would be preferable, or start point and destination.
- Record flights, if possible with total flight distance, otherwise flight start point and destination for each leg of the journey.
- Record long distance train journeys, again with start point and destination for each leg of the journey.

2.3.3 Commute

- In the travel survey question "Distance travelled to work by mode" the public transport option should be broken down into rail, underground, bus and tram/light rail.
- If a combination of modes is used by an individual in their regular journey then record the approximate distance by each mode, or failing that then the main mode used. If however, the combination refers to travelling by a different mode each day, then record the regularity of travel by a certain mode.
- Record more precise distances, especially for journeys over 30 miles.

2.3.4 Other

- Record fuel use or mileage for courier and delivery companies by type of vehicle.

2.4 Waste

The footprinting tool is set up so that emissions can be calculated from tonnage figures for landfill, incineration, recycling and composting. These have to be reported as Best Value Performance Indicators (BVPIs) so data should be readily available. Recycling can be further broken down by material, as is currently the case, to improve accuracy. Therefore there are no further recommendations for waste data.

2.5 Renewables and CHP installations

As for buildings, it is recommended that LB Waltham Forest maintain a list of renewables and CHP installations at their own sites. Ideally these should be metered so that generation can be monitored.

3 Carbon footprint: Results

3.1 Total emissions

The total emissions for LBWF council for the year April 2006 – March 2007 have been estimated at 40,704 tonnes CO_2. The breakdown of emissions by source is given in Table 3 and Figure 2 below.

Emissions source	CO_2 Emissions (tonnes/year)	CO_2 Emissions (%)
Energy consumption	33,368	82%
Fleet fuel consumption	5,283	13%
Staff commute	4,459	11%
Travel for work	209	1%
Energy generation	-2,615	-6%
Total	**40,704**	**100%**

Table 3 Total emissions for 2006 – 2007

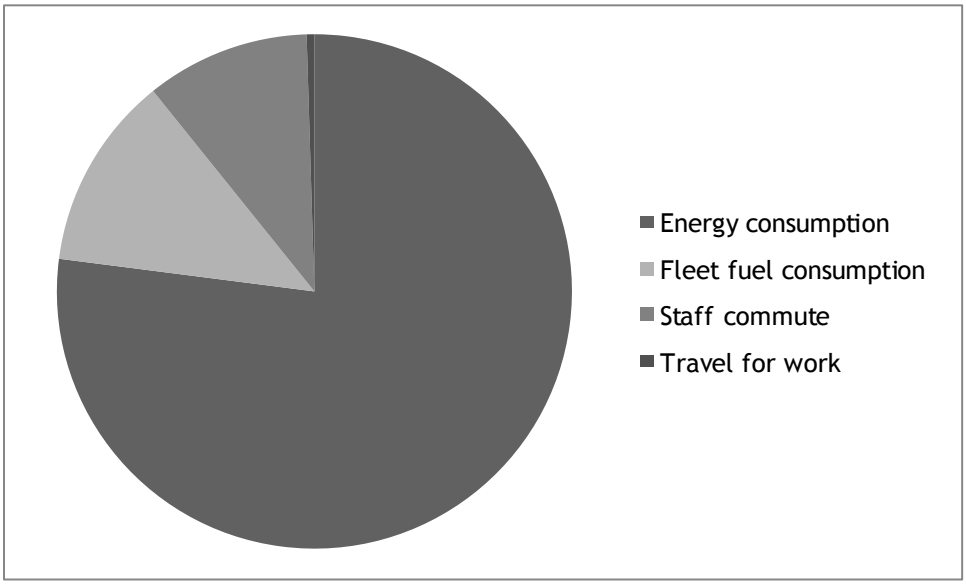


Figure 2 Total emissions for 2006 – 2007, excluding energy generation

Waste processing confers an emissions reduction of 6,642 tpa, based on the EU figures used for this analysis. Including waste, the total footprint would reduce to 34,062 tpa. Waste treatment could be considered as part of the carbon footprint of the council even though the great majority of the waste is not produced by the council because the council bears the responsibility for managing the waste produced. However the current consultation on the forthcoming indicators for Local Authorities[1] suggests that waste will not be included, and therefore it is not reported in the total figure here.

Note that these results are only as accurate as the data provided. The emissions from each source have been broken down further into different sub-categories, depending on the source type. These are outlined below together with comment on possible areas of verification or improvement.

3.1.1 Building emissions

Emissions resulting from building energy use have been broken down by fuel type and this is shown in Table 4 and Figure 3 below. These have been calculated using estimates of the total electricity and gas use, although

[1] http://www.communities.gov.uk/publications/localgovernment/indicatorsdefinitions

the database tool has been set up to use actual billing data from all council buildings to calculate future footprint figures. It is thought that the total gas and electricity consumption figures are reasonably accurate, although some sites with low levels of fuel consumption might have been omitted. Therefore the figures are likely to have been underestimated by up to 10%.

Fuel type	CO_2 Emissions (tonnes/year)	CO_2 Emissions (%)
Electricity	15,889	48%
Natural Gas	17,479	52%
Total	**33,368**	**100%**

Table 4 Building energy use; broken down into electricity and natural gas

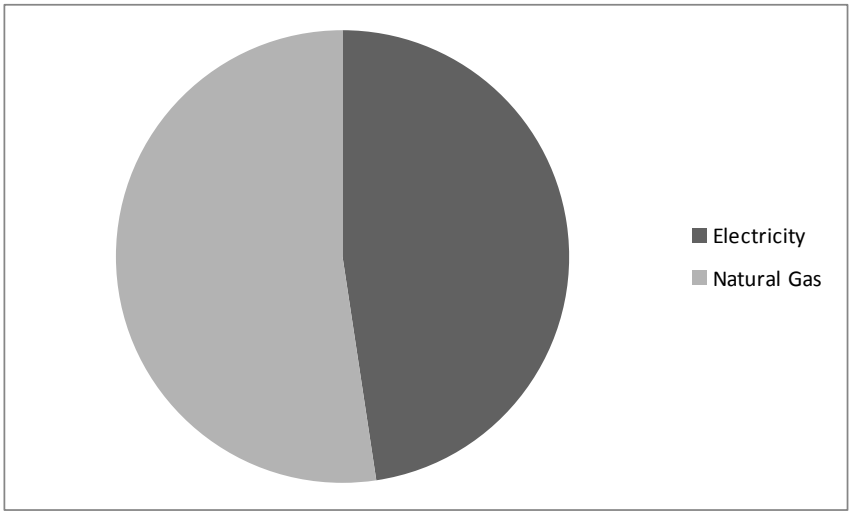


Figure 3 Building energy use; broken down into electricity and natural gas

3.1.1.1 Green tariff electricity

It is understood that the half hourly metered electricity used by Waltham Forest, a total of 6.37 GWh, is sourced from green tariff supplies. Defra guidelines state that a zero emissions factor can be applied if electricity is supplied from a renewable source through an energy supplier that has acquired climate change levy (CCL) exemption certificates. Applying a zero factor to 6.37 GWh would reduce the carbon footprint by 3,332 tpa to give a total of 12,557 tpa for electricity consumption and an overall footprint of 26,066 tpa.

However this has not been counted in the footprint reported here for two reasons. Firstly the precise nature of the green tariffs has not been fully investigated to check whether or not all of this electricity does in fact qualify for CCL exemption certificates. Secondly renewables are a part of the grid mix used to calculate the emissions factor for grid electricity, and therefore the reduction in emissions as a result of using renewable generation has already been counted and shared equally amongst all electricity consumers. It could therefore be argued that, while green tariffs can provide a statement of support and a financial boost for the renewables industry, there is a danger of double counting if these are considered zero carbon at the point of use.

3.1.1.2 Street lighting

Electricity used for street lighting and illuminated street furniture is included within the total electricity consumption in Table 4 above. This is an unmetered supply and is therefore estimated. The total consumption figure for street lighting is 7.7 GWh, approximately 25% of the total electricity consumption for the council.

The following are not included in the street lighting figure:

- Lighting in parks and recreational areas

- Metered street lighting
- Traffic signals
- Highway drainage pumping stations
- Sections of road in the borough that are operated by TfL (A406 North Circular and A12)

Street lighting on housing estates is included in the buildings figure from the landlords supplies at these sites.

3.1.1.3 Contractors

The principal outsourced services in Waltham Forest are waste collection (contracted to Verdant) and council housing through an Arms Length Management Organisation (ALMO), Ascham Homes. Ascham Homes fuel consumption for Landlord supplies (such as communal areas and external lighting) is included in the buildings emissions. Waste collection has only been outsourced very recently, and was an in house service during the time covered by the consumption data (2006/7). Therefore gas and electricity use in buildings associated with waste collection has been included.

3.1.2 Fleet fuel emissions

Table 5 and Figure 4 below show the breakdown of emissions resulting from the borough's fleet fuel consumption shown by fuel type. Energy used to power electric vehicles in the fleet has already been included in the electrical consumption reported from the building stock.

Fuel Type	CO_2 Emissions (tonnes/year)	CO_2 Emissions (%)
Diesel	5,182	98.1%
Petrol	91	1.7%
LPG	10	0.2%
Total	**5,283**	**100%**

Table 5 Breakdown of fleet fuel consumption emissions by fuel type

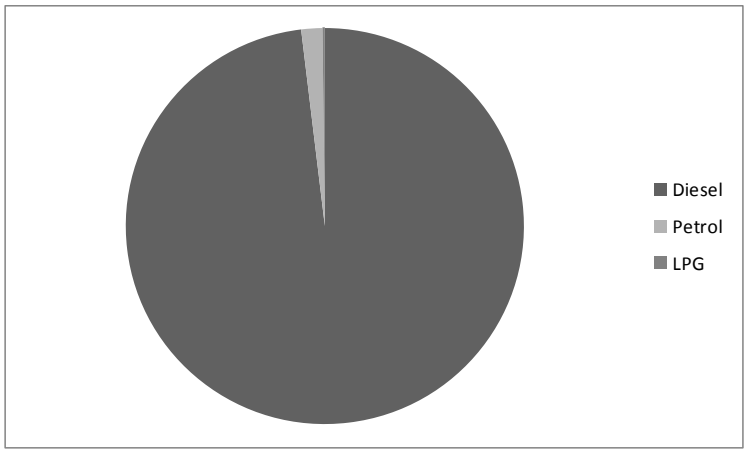


Figure 4 Breakdown of fleet fuel consumption emissions by fuel type

3.1.2.1 Contractors

As described in Section 3.1.1.3 above, the principal contractor's fleet would be the waste collection vehicles. The fuel figures provided include these from the time when the service was operated in house.

3.1.3 Travel for work emissions

The calculation for emissions arising from work related travel was based on a single mileage value and so it was necessary to use an estimated emissions factor for an average car (with unknown fuel type), see 8.3.2

and 2.3.2 for more information. It is possible to enter more specific vehicle types and emissions factors within the tool to provide a more accurate figure for the total annual emissions.

Vehicle	CO_2 Emissions (tonnes/year)
Average car	209

Table 6 Emissions from Travel for work

3.1.4 Emissions from the staff commute

The Staff Travel Survey was used to estimate the emissions resulting from the borough staffs commute to work. Approximations had to be used for the average mileage of each journey due to the format of the data collected. The mileage was then doubled to account for the journeys both to and from work then multiplied by the number of working days and the total number of staff working in the borough to get the final figures for each mode of transport.

For future year's carbon footprint calculations, it would be useful to request more detailed information on the length of journeys and the mode of transport (where more than one is used in a single journey).

Mode of transport	CO_2 Emissions (tonnes/year)	CO_2 Emissions (%)
Walking/Cycling	0	0.0%
Motorcycle	34	0.8%
Car	3,479	78.0%
Car share	228	5.1%
Bus	392	8.8%
Tube	22	0.5%
Train	18	0.4%
Public Transport (combination)	206	4.6%
Public transport (with cycle)	23	0.5%
Public transport (with car)	57	1.3%
Total	**4,459**	**100.0%**

Table 7 Emissions from staff commute to work

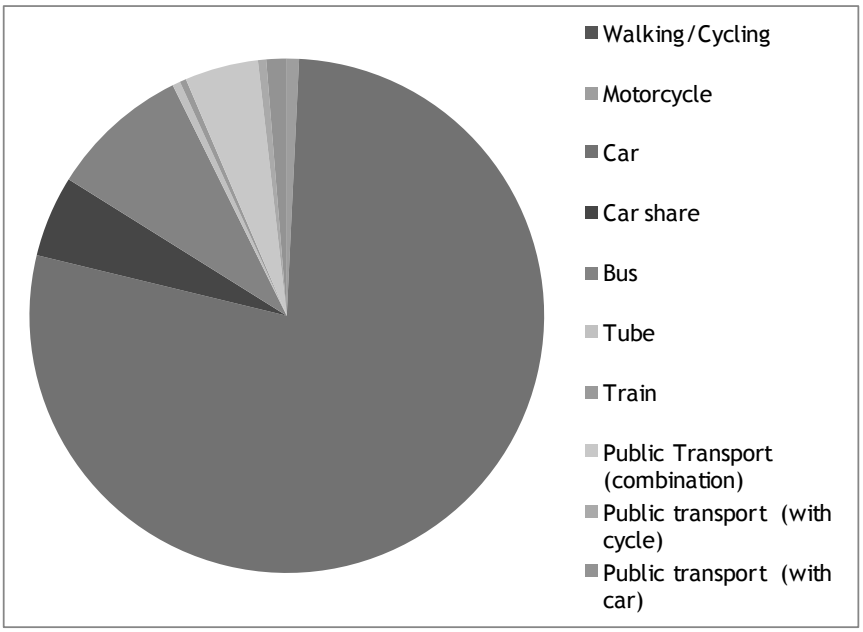


Figure 5 Emissions from staff commute to work

3.1.5 Waste processing emissions

Table 8 below shows the emissions, for the different disposal routes, of waste processed in the borough. As discussed in Section 8.4, the table shows that all waste, except that sent to landfill, is considered as a net *reduction* in emissions as the embodied energy of the waste products are not considered here.

Disposal route	CO_2 Emissions (tonnes/year)
Landfill	4,458
Incineration	-607
Composting	-375
Recycling – glass	-865
Recycling – plastic	-418
Recycling – paper and card	-5,436
Recycling – cans	-924
Recycling – textiles	-369
Recycling – other	-2,107
Total	**-6,642**

Table 8 Emissions (net) from waste processing

3.1.6 Energy generation emissions

The net emissions for the different energy generation technologies for the borough have been estimated from the anecdotal evidence provided. As none of the installations are metered the output has been calculated from the capacity and hours used. We recommend that a list be produced of generators in the borough and meters installed to provide a far more accurate record of energy use and hence CO_2 emissions generated.

Technology	CO2 Emissions (tonnes/year)
CHP	-2,614
PV	-0.73
Total	**-2,615**

Table 9 Emissions (net) from energy generating technologies

4 Database tool

This tool has been created to calculate the carbon emissions from the London Borough of Waltham Forest's operations, based on data provided about energy use in buildings and other activities which generate carbon emissions including transport, waste processing and energy generation. It has been designed to enable the borough to calculate emissions for past and future years and to be configurable to allow for future developments including the introduction of new technologies and updated emission factors.

The use and design of the tool are described in more detail in accompanying documentation.

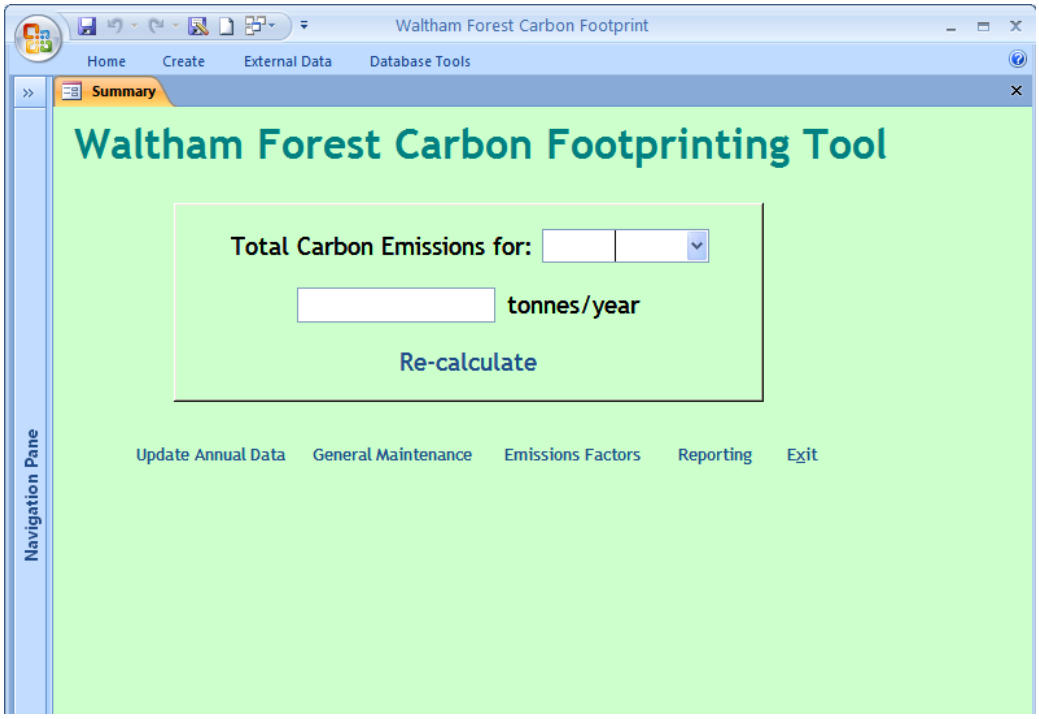


Figure 6 Carbon footprinting database tool

4.1 Resources

The tool has been designed for use by one or a small number of Council officers who would be charged with updating and maintaining the database tool.

This will require the following tasks:

- Collecting and entering annual fuel use and waste generation data
- Updating data such as the list of corporate and contractors buildings, renewable energy and CHP installations and current emissions factors
- Periodic reporting of results
- Possibly adapting the design or structure of the database to accommodate unforeseen changes in calculation or reporting methodologies

Resources will need to be allocated to complete these tasks. The first three can be undertaken by anyone with a basic knowledge of working with databases. These are essentially data entry tasks that will be carried out regularly to produce periodic reports. It is likely to take a few days per report to gather data and enter it into the database tool.

Adapting the design and structure of the database would only be required occasionally, if at all, and would require a more detailed knowledge of Microsoft Access. This would depend on future changes to the way the council collects data and reports its carbon footprint or perhaps on the need to comply with reporting guidelines from Defra or other relevant authorities.

Note that implementing the system of regular carbon footprint recording will require an initial more intensive period of activity in order to set up the system and adjust working practices.

5 Wider community emissions

5.1 Introduction

In addition to calculating the carbon footprint of the Borough's own emissions, this chapter outlines estimates of the overall emissions from within the borough boundaries from energy use in domestic and non domestic buildings and from transport fuel consumption.

There are several different datasets assessing the baseline emissions and a range of different gases that could be included. The most useful of these in this context are those produced by Defra and LECI, outlined here. The results below are expressed in carbon dioxide (CO_2) emissions rather than carbon (C) emissions and are generally stated in tonnes per annum (tpa) or kilotonnes per annum (ktpa).

The second proposed Defra indicator described in Section 1.4 would use centrally collected Defra statistics. These statistics are described in this section. Other datasets are included in an appendix. The variation in results from the different calculation methods highlights the uncertainty in calculating these emissions. In the case of the LECI database, it is possible to further disaggregate emissions to target areas of the borough with higher levels of emissions.

Should the need arise to comply with any legislative requirements, the reporting of the emissions from the wider community can be updated at a later date once the relevant methodologies are published.

5.2 Defra Local and Regional CO_2 Emissions Estimates for 2004

Defra published updated estimates of carbon dioxide emissions at Local Authority level in November 2006. These are described as experimental, and not directly comparable with the 2003 data described above due to improvements in the raw data and modelling methods used.

The main changes over the 2003 dataset are:

- Energy sector emissions are re-allocated to end users. In 2003 this was only done for the electricity sector.
- Improved DTI electricity consumption data means that only 1.5% is unallocated to a Local Authority compared to 8% previously. Meter point locations have been more accurately allocated to LAs.
- Improved estimates of the distribution of solid and liquid fuels in the domestic sector.
- Improved estimates of emissions and removal of CO_2 due to land use, land use change and forestry (LULUCF)[2].

Sector	CO_2 Emissions ktpa
Domestic	529
Industry & Commercial	312
Road Transport	306
Land Use Change	2
Total	**1,149**

Table 10: CO_2 emissions by sector for Waltham Forest (Defra 2004)

[2] LULUCF include emissions sources and sinks from activities such as forest growth and soils compiled by the Centre for Ecology and Hydrology in Edinburgh.

5.3 London Energy and CO_2 Emissions Inventory (LECI) 2003

Published by Mayor of London in June 2006, the LECI 2003 is an annually updated database of related electronic files that hold geographically referenced datasets of energy consumption (in kWh) and the resulting CO_2 emissions (in tonnes/year) for the Greater London area in 2003. The LECI 2003 was compiled and is maintained by the Greater London Authority (GLA) as part of the implementation of the London Mayor's Energy Strategy.

The LECI 2003 provides energy consumption and CO_2 emission estimates at both London borough and $1km^2$ levels for various energy/fuel categories and sectors. The energy consumption and CO_2 emissions were split into three broad sectors: domestic, commercial and industrial, and transport. The database was also divided in energy/fuel sources. The following table shows different sources for the datasets used within the LECI 2003.

Energy/Fuel Source	Energy Fuel/Sector	Data Source
Electricity	Domestic / C&I	NAEI 2003/NETCEN and DTI
Gas	Domestic / C&I	LAEI 2003 (GLA 2006)
Oil	Domestic / C&I	NAEI 2003/NETCEN and DTI
Coal	Domestic / C&I	NAEI 2003/NETCEN and DTI
Renewables & Wastes	Domestic / C&I	NAEI 2003/NETCEN and DTI
CHP	Domestic / C&I	LAEI 2003 (GLA 2006)
Rails	Transport	LAEI 2003 (GLA 2006)
Road Transport	Transport	LAEI 2003 (GLA 2006)
Shipping	Transport	LAEI 2003 (GLA 2006)
Aviation	Transport	LAEI 2003 (GLA 2006)

Table 11: Sources, sectors and datasets used within LECI 2003

The LECI 2003 was provided in a database form (Microsoft Access) by the Environment Group's Energy Team (GLA). Most of the data can be exported to Microsoft Excel and linked to GIS software. For more information about the methodology used, please refer to the LECI 2003 report.

The following table shows the energy consumption and CO_2 emissions extracted from the LECI 2003 database. According to this database, the 2003 CO_2 emissions for Greater London were 43,665 ktpa while for Waltham Forest they were 945 ktpa.

	Domestic		Commercial & Industrial		Transport		Total	
Energy/Fuel Source	Energy GWh	CO_2 ktpa	Energy GWh	CO_2 Ktpa	Energy GWh	CO_2 Ktpa	**Energy GWh**	**CO_2 ktpa**
Gas	1,646	309	356	66	0	0	**2,002**	**375**
Electricity	408	175	364	167	0	0	**772**	**343**
Oil	19	5	60	16	0	0	**79**	**22**
Coal	1.8	0.6	0.054	0.018	0	0	**1.9**	**0.62**
Wastes & Renewables	0	0	4	0	0	0	**4**	**0**
Rail	0	0	0	0	14	9	**14**	**9**
Roads	0	0	0	0	756	197	**756**	**197**
Aviation	0	0	0	0	0.47	0.12	**0.47**	**0.12**
Totals	**2,076**	**490**	**783**	**249**	**771**	**206**	**3,630**	**945**

Table 12: LECI 2003 Energy Consumption and CO_2 emissions for Waltham Forest

The energy consumption and CO_2 emissions shown in the LECI 2003 are classed as experimental by the GLA. However, this database seems to be the most comprehensive and refined to date for the Greater London area. This version corresponds to an improved version of the previous LECI 2000 database. A new version of the database with figures from 2004 is due to be released in November 2007.

5.4 LECI 2003 – Modified

After analysing in detail the data obtained from LECI 2003, it was found that the way of assigning emissions to each Borough contains some inaccuracies. As mentioned earlier, London was divided into 1km^2 areas and each square was assigned to only one Borough. When a square falls between two Boroughs, the one that has the largest area of the square gets assigned all the energy use within that 1km^2. The grid squares included in LECI 2003 for Waltham Forest are shown shaded in Figure 7.

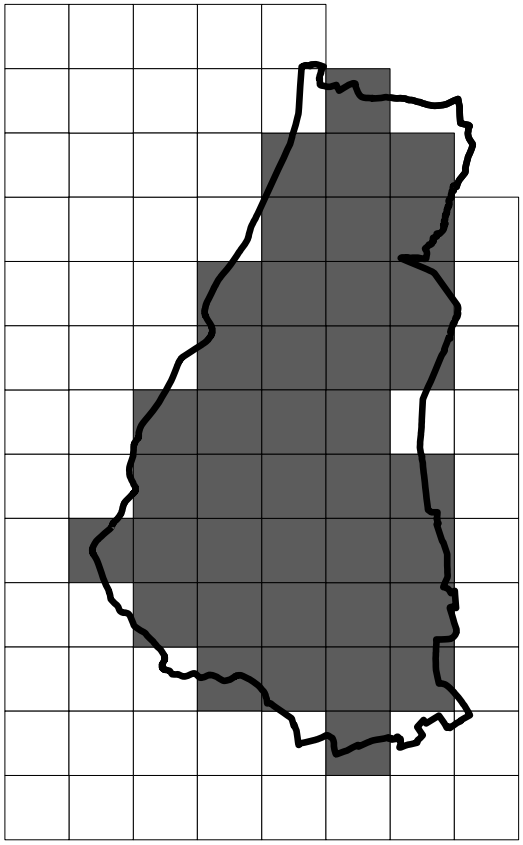


Figure 7 Grid squares included in LECI

It can be seen that in the case of Waltham Forest, LECI makes a reasonable approximation of the borough area. In addition, the boundary analysis is less critical for Waltham Forest because the border regions include reservoirs on the Lea Valley and Epping Forest, where CO_2 emissions would be low.

By calculating the area of each grid square within the Waltham Forest boundary and the CO_2 emissions from each grid square according to LECI 2003, it is possible to assign CO_2 emissions to each grid square shown in proportion to the area within the borough. Adding these values gives a more accurate estimate of the total emissions for Waltham Forest.

Furthermore, it was found that emissions factors used for electricity are not consistent with the other emissions datasets outlined here. The factor used for electric trains was out of date, while the factor used for grid electricity was the long term marginal factor[3] of 0.43. The grid emissions factor for 2003 was substituted in both cases and the CO_2 emissions recalculated. This slightly reduces the emissions from rail and increases the emissions from electricity consumption.

[3] This is the factor used to assess carbon savings from policies or measures that produce long term reductions in emissions, based on the assumption that such measures will displace new efficient generating plant over time periods of a decade or more. This factor is lower than the current national grid emissions factor.

	Domestic		Commercial & Industrial		Transport		**Total**	
Energy/Fuel Source	Energy GWh	CO_2 ktpa	Energy GWh	CO_2 Ktpa	Energy GWh	CO_2 Ktpa	**Energy GWh**	**CO_2 ktpa**
Gas	1,605.8	301.3	351.0	64.9	0.0	0.0	**1,956.9**	**366.2**
Electricity	393.9	207.3	348.7	183.5	0.0	0.0	**742.7**	**390.8**
Oil	19.3	5.2	57.3	15.5	0.0	0.0	**76.6**	**20.7**
Coal	0.0	0.6	0.0	0.0	0.0	0.0	**0.1**	**0.6**
CHP	0.0	0.0	44.4	9.9	0.0	0.0	**44.4**	**9.9**
Wastes & Renewables	0.0	0.0	4.6	0.0	0.0	0.0	**4.6**	**0.0**
Rail	0.0	0.0	0.0	0.0	14.6	8.0	**14.6**	**8.0**
Roads	0.0	0.0	0.0	0.0	757.0	197.2	**757.0**	**197.2**
Aviation	0.0	0.0	0.0	0.0	0.4	0.1	**0.4**	**0.1**
Totals	**2,019.1**	**514.4**	**806.1**	**273.9**	**772.0**	**205.4**	**3,597.2**	**993.6**

Table 13 LECI 2003 Energy Consumption and CO_2 Emissions for Waltham Forest - Modified

5.5 Comparison of Datasets

Table 14 and Figure 8 below show comparisons of the different datasets described in this chapter and in Appendix 9. Domestic and C & I emissions are similar for LECI, Defra and DTI figures for 2003 except that the C & I emissions from the Defra figures include rail fuel use. This is to be expected because there is reasonable accuracy in the locations and fuel use by meter. The area of greatest uncertainty is transport because these figures rely on a modelling process to estimate how much fuel is consumed within the borough boundaries.

One discrepancy is that the Defra estimates increase significantly from 2003 to 2004, while most elements of the DTI estimate do not show the same increases, as shown in Table 28 to Table 30.

Model / CO_2 emissions ktpa	Domestic	C & I	Transport	Total
LECI 2003 (modified)	514 (52%)	274 (28%)	205 (21%)	994
LECI 2003	490 (52%)	249 (26%)	206 (22%)	945
Defra 2004	529 (46%)	312 (27%)	306 (27%)	1147
Defra 2003	572 (44%)	472 (36%)	262 (20%)	1305
DTI 2003	545 (50%)	285 (26%)	263 (24%)	1093

Table 14 CO_2 emissions by model

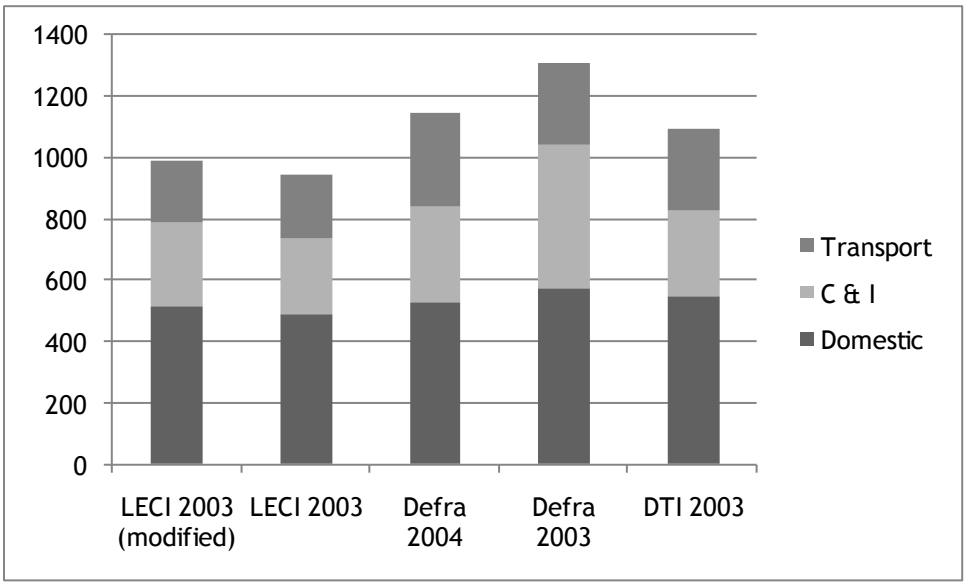


Figure 8 CO_2 emissions for different models

5.5.1 Choice of dataset

The choice of the most appropriate dataset to report emissions from LB Waltham Forest will depend on the end use of the data. If this information is to be reported as a BVPI or other performance indicator then the reporting methodology will specify the source of the data. At present it seems likely that this would require the use of the Defra data for the Defra proposed indicator.

The alternative datasets are useful, particularly for breaking down the emissions figures further within local authority boundaries. LECI data can be analysed by 1 km^2 grid squares and the DTI data can be examined at SOA level, as shown in Section 5.6 below and Appendix 10.

5.6 Emissions breakdown

The Mayor's Climate Change Action Plan (CCAP)[4] breaks down emissions by sector for London as shown in Figure 9, Figure 10 and Figure 11 below. The breakdown by source for Waltham Forest might differ from the breakdown for London as a whole, but these figures do provide some indication of the source of emissions in each sector.

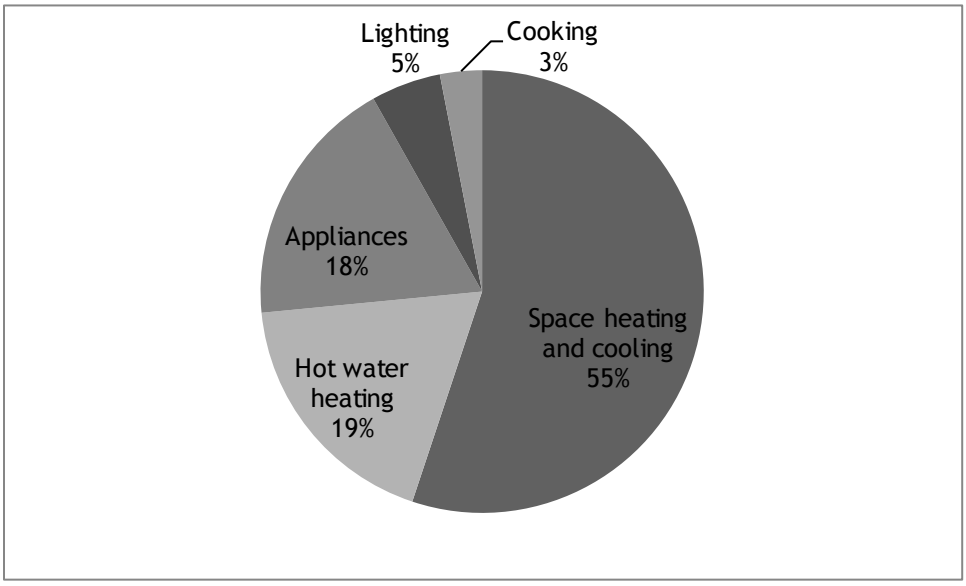


Figure 9 Emissions from the domestic sector by source (CCAP)

[4] Climate Change Action Plan, GLA, February 2007, http://www.london.gov.uk/mayor/environment/climate-change/ccap/index.jsp

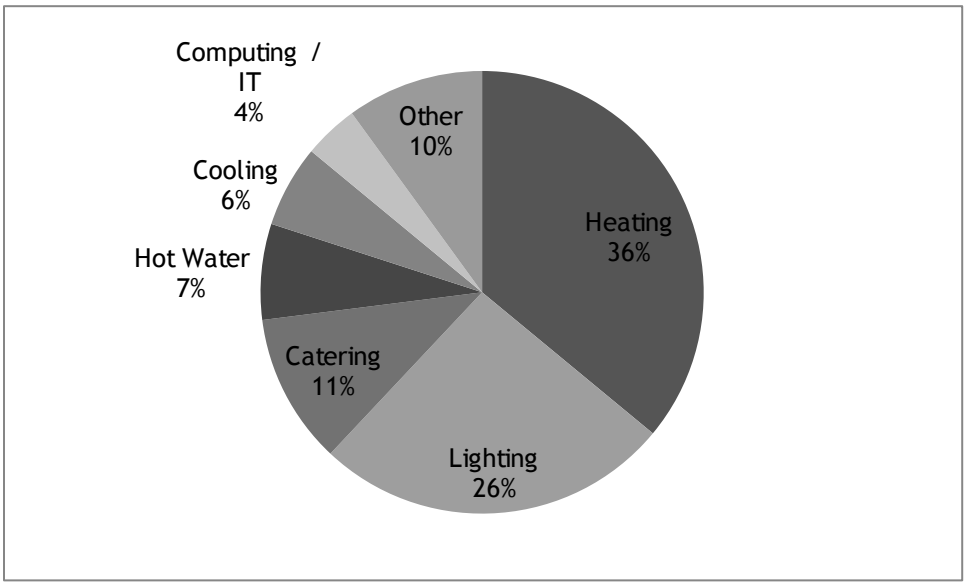


Figure 10 Emissions from the commercial and industrial sector by source (CCAP)

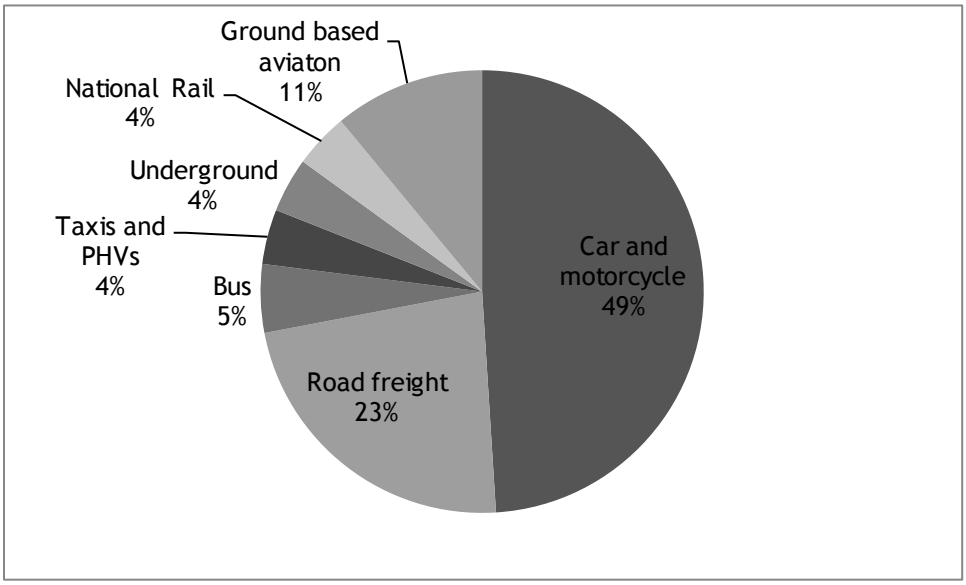


Figure 11 Emissions from the transport sector by source (CCAP)

In the case of transport, the LECI data for Waltham Forest is broken down further into road and rail as shown below:

Source	CO_2 emissions (tpa)	CO_2 emissions (%)
Roads	197,246	96%
Rail	8,016	4%
Total	**205,263**	**100%**

Table 15 Emissions from transport by source

This indicates that in Waltham Forest road transport accounts for a higher share of emissions than it does for London as a whole. Rail and aviation emissions account for a lower proportion.

5.7 Emissions by ward and postcode sector

It is helpful to know how emissions are distributed around the borough so that measures to reduce emissions can be targeted.

Unfortunately the available emissions datasets are not broken down by ward or by postcode sector. The LECI data however is broken down by 1 km^2 grid squares. Using the modified LECI data, thematic maps can be produced and overlaid with ward or postcode sector boundaries.

Figure 12 below shows the CO_2 emissions using the modified LECI data for all sectors: domestic, non domestic and transport.

Clearly higher emissions are found in the south of the borough, particularly the wards of Cann Hall, Cathall, Grove Green and Leytonstone. Middle ranges of emissions are found along the centre of the borough, with the lowest emissions around the borough boundary particularly to the north and east and to a lesser extent the west.

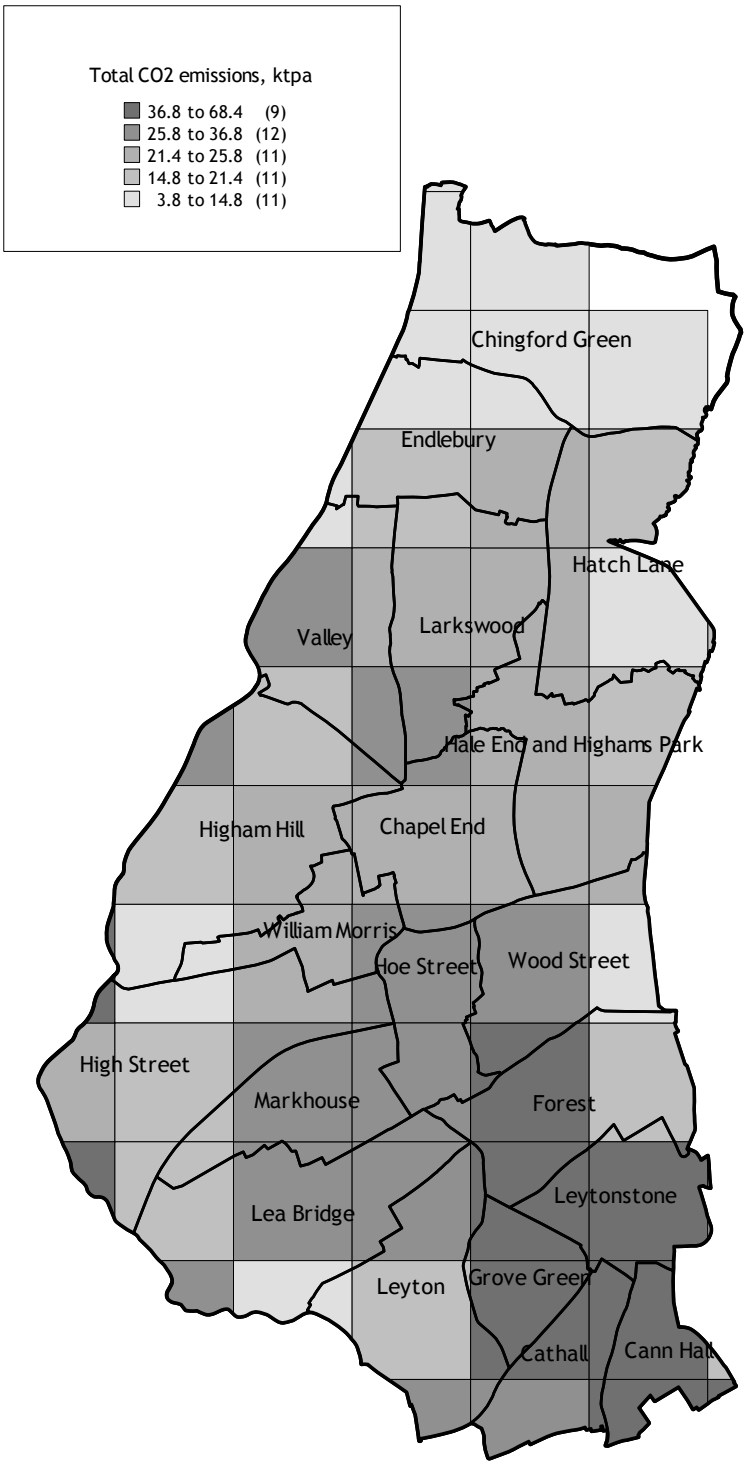


Figure 12 CO_2 emissions (kt/km^2), all sectors

This data is further broken down in Appendix 10. Figure 15 shows the same map as Figure 12 above but with postcode sectors overlaid instead of ward boundaries. The area of highest emissions corresponds to postcode sectors E113, E114, E106 and E111 (Leyton and Leytonstone).

Note that the LECI grid does not extend as far as the Waltham Forest boundary in the north-east corner (see Figure 7 above), which is why no emissions are assigned here.

Figure 16, Figure 17 and Figure 18 show CO_2 emissions from non domestic buildings, domestic buildings and transport respectively. This shows that, compared to the total emissions, non domestic buildings emissions are spread more evenly over the south and west of the borough, domestic buildings emissions are more

concentrated in the area of high emissions in the south; and transport emissions are highest in the centre of the borough.

Figure 19, Figure 20 and Figure 21 show the densities of population, dwellings and the area of non domestic buildings by ward using national statistics land use and census 2001 data. It is clear that higher emissions from the domestic sector correspond to the areas of higher population density and higher density housing. Similarly the area of land taken up by non domestic buildings is higher across those wards showing higher emissions from the commercial and industrial sector. It is difficult to draw conclusions from the transport data as this does not relate to a static measure.

The Department for Business, Enterprise and Regulatory Reform (BERR, formerly DTI) have published electricity and gas consumption data at super output area (SOA) level. There are 28 of these in Waltham Forest and the advantage of SOAs is that they have approximately equal populations. Figure 22 and Figure 23 show domestic CO_2 emissions per household and per capita calculated from domestic gas and electricity use by SOA. These show higher emissions in the north of the borough indicating that the houses here are either less efficient or bigger or both.

Many measures to reduce emissions apply at the level of an individual building and in the case of dwellings these might best be targeted in the north of the borough. Others, notably CHP schemes, can be more economic in a more densely populated area such as the south east and centre of the borough.

6 Projected emissions growth

Emissions from new build have been estimated for domestic and for commercial and industrial property.

In both cases, estimates of the floorspace for new build have been produced and combined with emissions factors per unit area to give the estimated emissions.

The total projected growth is 16,780 tonnes CO_2 per annum by 2016, made up of an increase in emissions of 9,838 tpa in the domestic sector, 7,373 tpa in the transport sector and a net reduction of 431 tpa in the commercial and industrial sector.

6.1 Commercial and industrial

The change in demand for floorspace for commercial and industrial buildings has been estimated using data from a draft report by URS[5] and retail floorspace from the report "Shaping Our Future" produced by Shared Intelligence[6]. These show an projected increase in demand for retail floorspace and slight increase in offices, but a decrease in warehouse and factory floorspace.

The emissions rates per unit of floorspace are based on figures taken from CIBSE[7,8], using projected new build emissions rates where an increase in floorspace is expected and existing building benchmarks where a reduction in floorspace is projected (since existing buildings will be converted or demolished).

This would lead to a net decrease in emissions due to new commercial and industrial buildings in the borough of 43 tonnes of CO_2 per annum each year to 2016, a total reduction of 431 tpa in emissions by 2016. This is because the loss of warehouse and factory floorspace cancels out the projected growth in retail and office floorspace.

Building type	Projected additional floorspace (m^2)	Emissions rate ($kgCO_2/m^2$)	Projected additional emissions (tCO_2)
Retail	1,800	40	72
Office	185	36	7
Factory	-4,053	21	-83
Warehouse	-877	44	-38
Total	**-2,945**		**-43**

Table 16 Annual change in Commercial and Industrial emissions by bulk category

6.2 Domestic

The increase in the amount of housing floorspace is based on the average size of new build homes in Waltham Forest being a two bedroom flat and the number of projected completions of dwellings per year from figures provided by LBWF[9]. This figure includes the developments at Blackhorse Lane and Walthamstow town centre as well as a series of other smaller developments. The estimated annualised increase in dwelling floorspace is 74,000m^2 per year.

The emissions were calculated assuming that to 2010, 95% of homes will be built to meet the requirements in the building regulations and 5% to meet current best practice. Post-2010, the building regulations are expected to become much more stringent, meeting level three for energy from the Code for Sustainable Homes (CfSH) and from 2013 changing again to meet level four of the CfSH. Both of these require emissions

[5] URS, LB Waltham Forest Employment Land Study (Draft Report), August 2007

[6] Shared Intelligence, *WALTHAM FOREST Shaping Our Future: Key Drivers of Change*, June 2007

[7] CIBSE, *Energy efficiency in buildings CIBSE Guide F*, January 2004

[8] BSJ, Model behaviour, p. 47, Volume 29, Number 9, September 2007

[9] Personal communication – extract from LBWF housing trajectory. This figure is provisional at this stage and will be ratified as part of Housing Capacity Study being undertaken in 2007 to contribute to the LDF process.

rates lower than the existing best practice performance and so from 2011/2012, all new build is modelled as meeting building regulations. The emissions rates for the projected building regulations and for best practice are shown in Table 17 .

Building emission rates ($kgCO_2/m^2$)	2006 Building regulations[10]	2010 Building regulations[11]	2013 Building regulations[12]	2007 Best Practice
Space heating[13]	12.03	9.02	6.74	7.76
Electricity	11.45	8.59	6.41	11.45
Total	**23.48**	**17.61**	**13.15**	**19.21**

Table 17 Emissions rates for new build homes

Combining the projected emissions with the projected completions figures gives the following results:

Year	Projected completions (number of dwellings)	Projected additional emissions (tCO_2 per annum)	Projected cumulative emissions (tCO_2 per annum)
2006/07	556	777	777
2007/08	867	1,212	1,989
2008/09	720	1,006	2,995
2009/10	940	1,314	4,308
2010/11	789	1,103	5,411
2011/12	1454	1,536	6,947
2012/13	901	952	7,899
2013/14	911	963	8,862
2014/15	964	360	9,221
2015/16	788	294	9,516
2016/17	864	322	9,838
Total	**9754**	**-**	**9,838**

Table 18 Projected additional emissions from new housing

The total emissions from new build housing are projected to be 9,838 tCO_2 per annum by 2016/2017. The annual emissions for each phase of building regulations do not show the effect of building regulations very clearly as emissions increase more rapidly due to the greater number of homes built.

Beyond 2016 all new homes are due to be zero carbon. If this is achieved, there will be no additional emissions due to new housing beyond 2016.

6.3 Transport

Transport emissions growth can be estimated from population projections. By assuming that transport emissions growth will be at the same rate as population growth, it is effectively assumed that any new people in the borough will use the same average mix of transport modes to cover the same average distances with the same carbon intensity as the current residents. This would seem to be a reasonable business as usual model.

Projections for the population of Waltham Forest are shown in Table 19 below.

[10] Based on the BRE Osbourne demonstration house

[11] DCLG *Building Regulations Energy efficiency requirements for new dwellings A forward look at what standards may be in 2010 and 2013*, July 2007

[12] DCLG *Building Regulations Energy efficiency requirements for new dwellings A forward look at what standards may be in 2010 and 2013*, July 2007

Year	2004	2006	2011	2016	2021	2026	2029
Population (thousands)	221.8	223.1	224.9	228.2	232.2	236.0	238.1

Table 19 Population projections for Waltham Forest[14]

Table 19 shows an increase in population of 2.89% between 2004 and 2016. Transport emissions were 205 ktpa according to LECI 2003 (modified) and 306 ktpa according to Defra 2004 figures. This gives a projected growth of between 5,915 tCO_2 per annum and 8,830 tCO_2 per annum by 2016/2017. Taking an average of the two figures gives a projected growth of 7,373 tCO_2 per annum.

[13] Assuming natural gas is used for space heating

[14] 2004 Sub-National Population Projections (SNPP) for England published by the Office for National Statistics.

7 Conclusion

7.1 Results

The carbon footprint of LB Waltham Forest operations has been estimated to be **40,704 tpa**. This is approximately 3.5% to 4% of the total emissions from within the borough boundary, which are estimated to be between **994 ktpa** and **1149 ktpa** depending on the choice of dataset, and are expected to rise by **16.8 ktpa** by 2016.

Emissions source	CO_2 Emissions (tonnes/year)	CO_2 Emissions (%)
Energy consumption	33,368	82%
Fleet fuel consumption	5,283	13%
Staff commute	4,459	11%
Travel for work	209	1%
Energy generation	-2,615	-6%
Total	**40,704**	**100%**

Table 20 Total emissions from LBWF operations for 2006 – 2007

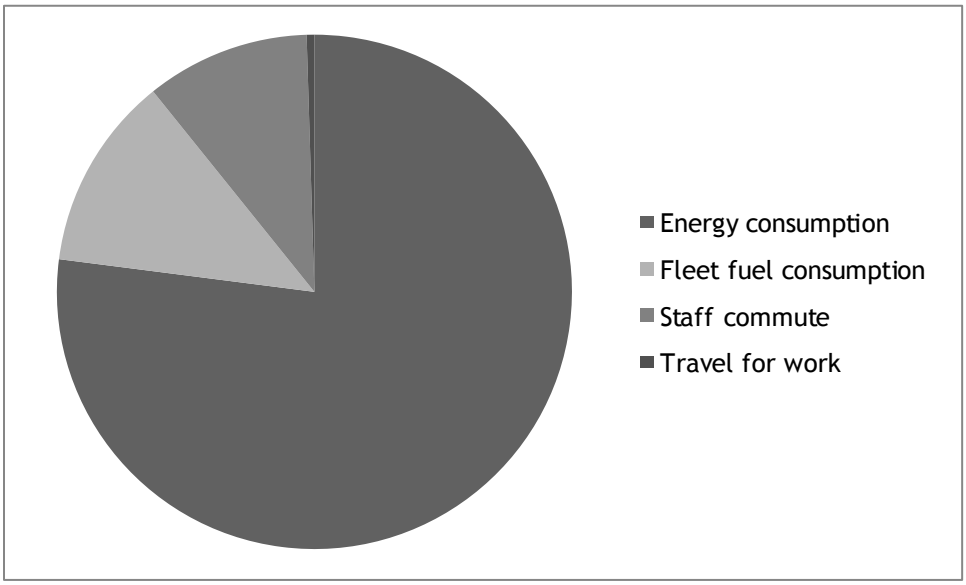


Figure 13 Total emissions for 2006 – 2007, excluding energy generation

Table 20 and Figure 13 above show that the greatest source of emissions is energy use in buildings. Staff commuting generates significantly more emissions than travel for work and fleet fuel use.

Waste treatment in the borough is not included in the footprint shown here, and generates a net reduction in emissions of 6,642 tpa due to displacement of energy and materials through recycling and incineration. Including this would reduce the overall footprint to 34,062 tpa.

Geographically, the highest emissions densities correspond to higher population and building densities in the south and centre of the borough. However the less densely populated areas in the north of the borough have higher per capita domestic emissions suggesting that dwellings here are either less efficient or bigger in size or both.

7.2 Comparison with other London boroughs

SEA/Renue has compiled a list of emissions for all London Boroughs using the datasets described above with a ranking calculated from the average ranking according to the various datasets (see Appendix 11). This

indicates that Waltham Forest has the 7th lowest overall CO_2 emissions of the 33 boroughs and the 4th lowest per capita emissions.

However, the Defra emissions datasets indicate that the per capita domestic emissions are close to the average per capita domestic emissions for Greater London.

Compared to the nineteen outer London boroughs, Waltham Forest has the 6th lowest overall emissions, the 7th lowest per capita domestic emissions and the lowest overall per capita emissions.

It is difficult to assess how the council's own footprint compares with others at this stage. This is likely to become possible in time as more LAs publish carbon baseline figures (perhaps as a BVPI). Alternatively, if the database tool is used to collect energy consumption and floor area data for the council building stock then this would allow a comparison with building benchmarks.

7.3 Targeting

Clearly energy use in buildings must be targeted in order to reduce the footprint of the council's activities. Reducing this by 20%, for example, would result in a reduction of more than the combined transport emissions total. Gathering individual consumption data for each building will enable more effective targeting of this sector.

In terms of transport, staff commuting is the dominant source of emissions. This is already being addressed through travel planning exercises and these should continue and expand.

For emissions from the wider community in Waltham Forest, around half of emissions come from energy use in domestic buildings with the remainder split between transport and non domestic buildings. The greatest source of emissions growth is also projected to come from new domestic buildings, closely followed by transport. Clearly there is a need to target domestic buildings in order to make the biggest impact on CO_2 emissions from the borough as a whole.

7.4 Recommendations

A list of recommendations has been provided, which would enable maximum benefit to be gained from the database tool and increase the accuracy of the footprint figure. These recommendations are summarised below:

- Use the list of buildings operated by LB Waltham Forest and its contractors to report annual energy consumption for each building from billing information.
- When specifying contracts for statutory services, annual energy consumption reporting could be required from contractors for buildings and fleet vehicles.
- When reporting a building's electricity consumption, it should be noted whether the bill is a green tariff exempt from the Climate Change Levy (CCL).
- When mileage claims are made for travel for work, record more details of the vehicle, such as engine size and/or VED band, fuel type, mileage and car make.
- Record motorcycle mileage claims separately to car mileage.
- Record public transport, taxi use and flights for work via expenses.
- When carrying out staff commuting surveys, break down responses featuring public transport or combinations of modes more accurately and record more precise distances.
- Record fuel use or mileage for courier and delivery companies by type of vehicle.
- Maintain a list of renewables and CHP installations at their own sites and in the borough as a whole.

7.5 Summary

It has been possible to estimate the carbon footprint of Waltham Forest with reasonable accuracy. In addition, a database tool has been created that will facilitate future calculations of the footprint figure.

Waltham Forest, like other local authorities, has not been required to report its carbon footprint in the past. New systems will therefore need to be maintained and suitable resources allocated to gather accurate data in order to regularly report the council's carbon footprint. A key outcome of this work is the list of recommendations that, combined with the database tool, will enable this to happen.

Estimating and updating the carbon footprint, particularly when improved data allows it to be broken down further, is a crucial first step in targeting and reducing CO_2 emissions.

8 Appendix: Carbon footprint methodology

8.1 Introduction

This section outlines the methodology used to calculate the carbon footprint for the London Borough of Waltham Forest.

Note that in addition to estimating the current carbon footprint, this work involved the design of a database tool that performs the calculations described here and can be updated in the future to calculate the footprint periodically. Details of the database design and a user guide for the tool can be found in a companion document.

8.2 Buildings emissions

The buildings emissions footprint has been calculated using consumption data for Council buildings (including Ascham Homes residential properties) for gas and electricity.

It has not been possible to link consumption data exactly to each building in the Council inventory. For the purposes of this report consumption data has come from a series of proposals for supply contracts, which includes annual consumption figures for a list of buildings and meters. It is not always clear which year the consumption data refers to, and there is no guarantee that consumption for all buildings and fuels is accounted for.

The database tool has been set up so that the list of properties held by LBWF officers can be maintained and premises managers can be contacted to provide up to date consumption figures for each building on a regular basis. This should improve the accuracy of the carbon footprint estimates in the future.

Emissions factors used for fuels from buildings are as shown in Table 21 below[15].

Fuel	Emissions factor($kgCO_2/kWh$)
Natural gas	0.206
Electricity	0.523*
Oil	0.281
Coal	0.346
LPG	0.225

Table 21 Fuel emissions factors for fuels used in buildings

* Electricity emissions factor is 5 year rolling average for 2001-2005 to smooth the effect of annual variations since the exact year of all the electricity consumption data is not known in every case.

8.3 Transport emissions

8.3.1 Fleet emissions

Data sourced direct from LB Waltham Forest, figures supplied for litres used by fuel from 2006-07. The following standard road transport conversion factors for kg CO_2 per unit were used, taken from Defra[16]:

[15] Guidelines to Defra's GHG conversion factors for company reporting, annexes updated 2007 www.defra.gov.uk/environment/business/envrp/pdf/conversion-factors.pdf

[16] Guidelines to Defra's GHG conversion factors for company reporting, annexes updated 2007 www.defra.gov.uk/environment/business/envrp/pdf/conversion-factors.pdf

Fuel	Emissions factor ($kgCO_2$/litre)
Diesel	2.630
Petrol	2.315
LPG	1.498

Table 22 Emissions factors for fleet fuel

8.3.2 Travel for work

Data on total mileage travelled by staff in cars for from 2006-07 was provided, enabling a calculation of emissions using an emissions factor of 0.334 $kgCO_2$/mile for an average car with undefined fuel type taken from Defra[17]. More detailed emissions factors are available broken down by fuel and engine size, so this estimate could be improved if more detail were known about the types of vehicle.

8.3.3 Staff commuting

Data to calculate figures for emissions from the staff commute have been taken from the Staff Travel Survey, undertaken between the 31st January and 14th February 2007 and completed by 30% of Council Staff.
The main data is from the question *Distance for Travel to Work split by Mode*, with figures for different types of public transport based on the more detailed percentages of staff that usually travel to work by each mode. Further breakdown of combination journeys is made as a weighted average based on TfL figures for Daily average number of journey stages in London[18].

It is assumed that walking and cycling will produce no CO_2 emissions. Standard passenger road transport conversion factors are used for motorcycles using petrol and cars using unknown fuel respectively; taken from Defra[19]. Car share assumes driver plus one passenger so the emissions are divided by two. Figures for CO_2 emissions per bus passenger are taken from TfL[20]. Standard average CO_2 emission per passenger kilometre are used for train and underground respectively; taken from Defra[21]. Figures for journeys involving a combination of modes assumes a split based on TfL transport figures for daily average number of journey stages in London[22].

The emissions factors used for the commuting element are as follows:

[17] Guidelines to Defra's GHG conversion factors for company reporting www.defra.gov.uk/environment/business/envrp/pdf/conversion-factors.pdf
[18] London Travel Report 2006, TfL (2006), www.tfl.gov.uk/assets/downloads/corporate/London-Travel-Report-2006-final.pdf
[19] Guidelines to Defra's GHG conversion factors for company reporting www.defra.gov.uk/environment/business/envrp/pdf/conversion-factors.pdf
[20] Transport for London Environment Report Dec 2006
[21] Guidelines to Defra's GHG conversion factors for company reporting www.defra.gov.uk/environment/business/envrp/pdf/conversion-factors.pdf
[22] London Travel Report 2006, TfL (2006), www.tfl.gov.uk/assets/downloads/corporate/London-Travel-Report-2006-final.pdf

Transport mode	Emissions factor (gCO_2/mile)
Walk	0.00
Cycle	0.00
Motorcycle	171.80
Car	334.00
Car share	167.00
Bus	165.76
Tube	84.65
Train	96.88
Combination bus, tube, train, DLR	127.83
Public transport and cycle	126.04
Public transport and car	210.30

Table 23 Emissions factors for transport modes

8.4 Waste emissions

The emissions factors used to calculate the carbon emissions from waste management were taken from EU data[23]. These figures calculate greenhouse gas emissions from the point of waste generation (the point at which the products become waste) forward rather than a life-cycle standpoint, mobilisation emissions accounting for collection, transport, sorting and processing of waste are accounted for in this methodology. Treatment options involving materials or energy recovery are therefore associated with a net *reduction* in emissions because the emissions prior to the product becoming waste are considered elsewhere.

The quantity of waste going via each treatment option is calculated using data supplied by LBWF. Using this data combined with the emissions factors; the net emissions from each treatment route can be calculated. The emissions factors are shown in Table 24 below.

Note that negative numbers indicate a net reduction in emissions. The figure for cans assumes a ratio of two ferrous cans to one aluminium can[24]. A proportion of the total amount of waste recycled was not assigned to a specific material category (glass, paper etc); for this fraction, the emissions factor for the recycling of source separated municipal solid waste (MSW) can be used.

[23] AEA Technology for the European Commission, *Waste Management Options and Climate Change*, July 2001.
[24] Waste online: metals recycling – aluminium and steel, http://www.wasteonline.org.uk/resources/InformationSheets/metals.htm

Disposal route	Emissions factor ($kgCO_2$ eq. / t waste treated)
Incineration	-10
Landfill[25]	327
Recycling – glass	-253
Recycling – paper and card	-600
Recycling – cans	-4007
Recycling - textiles	-3169
Recycling – plastic	-1126
Recycling – source separated MSW	-467
Composting	-37

Table 24 Greenhouse gas emissions from waste treatment

8.5 Renewables and CHP installations

Anecdotal evidence of renewables and CHP installations in the borough was provided. There are several CHP, one solar PV and two solar thermal installations. For the purposes of this study it is the electricity generation that is important since any thermal generation will be accounted for in gas consumption figures.

Because export metering is not available, it has been assumed that all generated electricity is exported, i.e. the generated electricity is subtracted from the total electricity consumption.

The following estimates have been made for the electricity generation from existing CHP and renewables:

Description	Technology	Capacity (kWe)	Hours per year	Electricity produced (kWh)
Five large flats estates (DHW), assumed operated for 17 hours per day	CHP	1,050	5,585	4,690,980
Two new units in sheltered housing blocks, assumed operated for 17 hours per day for half the year	CHP	24	2,792	53,611
Town Hall, designed to operate 3000 hours per year but 1500 assumed due to problems	CHP	165	1,500	198,000
Chingford Municipal Offices, zero operation assumed due to various problems	CHP	15	0	0
Waltham Forest Pool, designed to operate 17 hours per day but due to problems only 25% availability assumed	CHP	45	1,551	55,845
Walton House Residential Home, inoperable	CHP	30	0	0
St Mary's Primary School	PV	2	N/A	1,400
Chingford Municipal Offices	Solar thermal	0	N/A	0
Gwyn Jones Primary School	Solar thermal	0	N/A	0

Table 25 CHP and renewables installations

[25] It is assumed that all waste which is not treated through recycling, composting or the Edmonton incineration plant is landfilled.

The figures shown in Table 25 assume 90% availability for CHP and 80% average load. An annual output of 700 kWh/kW_p is assumed for solar PV.

9 Appendix: Emissions datasets

9.1 ONS Household Emissions Report

An Office of National Statistics (ONS) Report produced in 2004 examined the generation of greenhouse gases by UK households in 2001 and attributes them to the use of energy products, the use of transport and to the demand for goods and services. They include within the study remit carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride, a larger range of greenhouse gases than the studies outlined below. Emissions from final demand for other goods and services include emissions embedded in imports of goods and services. Effectively this represents an 'embodied' emissions approach seen from the household perspective.

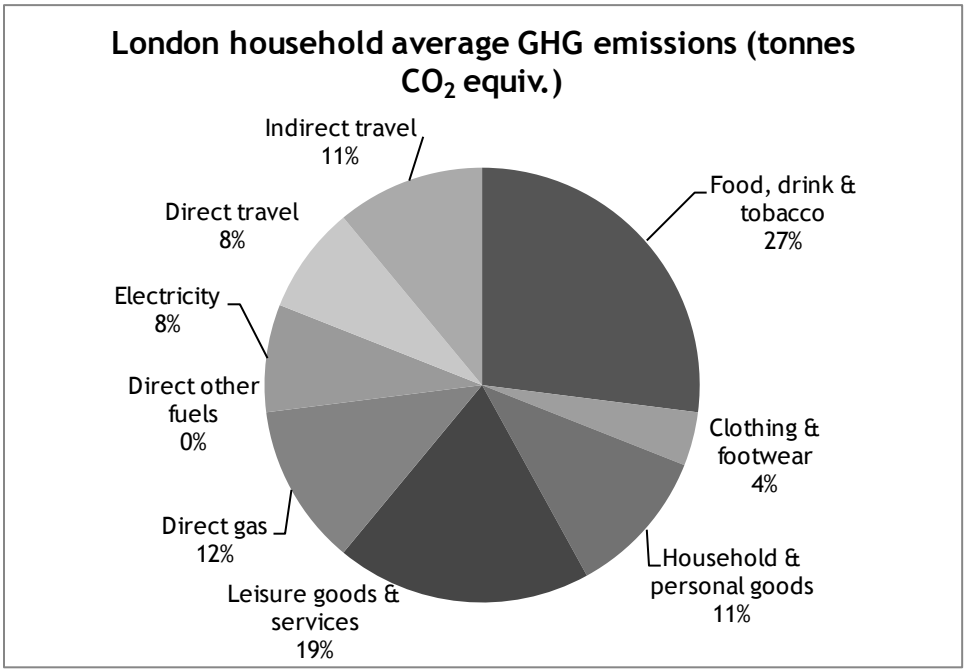


Figure 14 Breakdown of London household emissions including direct sources (ONS)

The report breaks down the figures regionally but not to the local authority so we have assumed the London figures are broadly representative of Waltham Forest. It can be seen that indirect emissions from goods and services accounts for some 60% of household emissions. This approach significantly increases the overall emissions that Waltham Forest is responsible for. This is because it includes transport outside of the borough (for instance air travel by residents) and the emissions associated with the import of goods and services.

The report states that London emits 77.2 million tonnes of CO_2, or 26.2 tonnes per household per year. At this rate, Waltham Forest's 89,788 households would be responsible for 2352 ktpa, considerably higher than the emissions predicted by the other models outlined below.

9.2 Regional Energy Consumption Statistics, BERR 2003

Estimates of total final energy consumption in 2003 published by the DTI (now BERR) for the first time in the December 2005 edition of Energy Trends. It includes gas consumption, road transport fuel and other fuel statistics at regional (NUTS1) and local (NUTS4) levels for 2003[26]. The information published for Waltham Forest by BERR is shown in Table 26.

[26] www.dti.gov.uk/energy/statistics/regional/index.html accessed January 2007

Fuel	Sector	Energy Consumption GWh
Coal	Industry & Commercial	0.0
	Domestic	1.8
	Total	1.8
Manufactured fuels	Industry & Commercial	0.0
	Domestic	4.6
	Total	4.6
Petroleum products	Industry & Commercial	34.5
	Domestic	19.5
	Road transport	1076.3
	Rail	0.3
	Total	1130.6
Natural gas	Industry & Commercial	536.9
	Domestic	1735.6
	Total	2272.5
Electricity	Industry & Commercial	329.7
	Domestic	398.8
	Total	728.5
Renewables & Waste	Total	2.9
Total		**4140.9**

Table 26: Total Energy Consumption for Waltham Forest, BERR 2003

The data provided for electricity consumption is classified as experimental and has now been released for 2003, 2004 and 2005. The transport figures were provided for BERR by Netcen. Netcen runs the National Atmospheric Emissions Inventory (NAEI) which is used by government departments, local authorities, regulators and industry. By using the above data in conjunction with CO_2 emission factors for the different fuels, it was possible to estimate the CO_2 emissions for the Borough, as shown in Table 27 below.

Fuel / Sector	Domestic ktpa	Industry & Commercial tpa	Transport ktpa	Total ktpa
Coal	0.6	0.0	0.0	0.6
Petroleum Products	5.1	9.0	262.5	276.6
Gas	329.8	102.0	0.0	431.8
Electricity	209.9	173.5	0.0	383.4
Total	**545.3**	**284.5**	**262.5**	**1092.4**

Table 27: CO_2 emissions by fuel & sector for Waltham Forest, BERR 2003

BERR have subsequently published gas consumption data for 2004 and 2005, road transport fuel consumption data for 2004, electricity consumption data for 2004 and 2005 and other fuels consumption data for 2004. These are summarised in the following tables. Note that there have been changes in the methodology used

to compile these datasets, and that some of the change seen in consumption levels could be a result of these changes.

Year		Domestic	Commercial and Industrial	Total
2003	Energy (GWh)	1,736	537	2,272
	CO_2 (ktpa)	337	104	441
2004	Energy (GWh)	1,596	434	2,029
	CO_2 (ktpa)	310	84	394
2004	Energy (GWh)	1,572	434	2,005
	CO_2 (ktpa)	305	84	389
Percentage change 2003 to 2004		-8.04%	-19.26%	-10.69%
Percentage change 2004 to 2005		-1.53%	0.00%	-1.20%
Percentage change 2003 to 2005		-9.45%	-19.26%	-11.77%

Table 28 Energy use and CO_2 emissions from gas consumption for Waltham Forest 2003 to 2005 (BERR)

Year		Domestic	Commercial and Industrial	Total
2003	Energy (GWh)	399	330	728
	CO_2 (ktpa)	210	173	383
2004	Energy (GWh)	380	365	746
	CO_2 (ktpa)	200	192	393
2005	Energy (GWh)	390	365	755
	CO_2 (ktpa)	205	192	398
Percentage change 2003 to 2004		-4.63%	10.83%	2.37%
Percentage change 2004 to 2005		2.44%	0.00%	1.25%
Percentage change 2003 to 2005		-2.30%	10.83%	3.64%

Table 29 Energy use and CO_2 emissions from electricity consumption for Waltham Forest 2003 to 2005 (BERR)

Year		Buses	Diesel Cars	Petrol Cars	Motor-cycles	HGV	Diesel LGV	Petrol LGV	Personal	Freight	Total
2003	Fuel use (kt)	4.7	8.7	45.5	0.7	9.7	12.4	1.6	59.7	23.7	83.4
	CO_2 (kt)	15.0	27.7	142.7	2.2	30.6	39.2	5.0	187.6	74.9	262.5
2004	Fuel use (kt)	5.0	9.4	44.7	0.6	9.5	11.9	1.4	59.8	22.8	82.6
	CO_2 (kt)	15.9	29.8	140.3	1.9	30.2	37.8	4.3	187.9	72.3	260.1
2005	Fuel use (kt)	5.3	10.3	44.2	0.6	10.2	12.1	1.2	60.5	23.5	83.9
	CO_2 (kt)	16.7	32.7	138.7	1.9	32.3	38.1	3.8	190.0	74.3	264.3
% Change 2003 to 2004		6.1%	7.7%	-1.7%	-11.6%	-1.3%	-3.8%	-14.9%	0.1%	-3.5%	-0.9%
% Change 2004 to 2005		5.0%	9.9%	-1.1%	-3.0%	7.0%	1.0%	-11.3%	1.1%	2.8%	1.6%
% Change 2003 to 2005		11.3%	18.3%	-2.8%	-14.2%	5.6%	-2.8%	-24.6%	1.3%	-0.9%	0.7%

Table 30 Road transport fuel consumption and CO_2 emissions for Waltham Forest 2003 to 2005 (BERR)

9.3 Defra Local and Regional CO_2 Emissions Estimates for 2003

The Defra CO_2 emissions estimates were first published in 2005 and produced by Netcen, part of AEA Technology, which is an extension of the National Atmospheric Emissions Inventory (NAEI).

This work was made possible following the publication of new local gas, electricity and road transport fuel consumption estimates by DTI (now BERR). The DTI electricity consumption data enabled Netcen to map for the first time carbon dioxide emissions from electricity generation to the point of consumption. This is a key difference to the data previously published by the NAEI where emissions have traditionally been attributed to the location of emission (e.g. at the power station locations).

The emissions from electricity consumption were estimated using an average UK factor in terms of kt CO_2 per GWh. This average allocates equal shares of coal, gas, oil and renewable powered generation to the electricity consumers and is derived from the UK inventory for 2003. The local CO_2 estimates presented in the report are split into three categories: domestic (including electricity use), industrial and commercial (not including power stations) and road transport. Natural (e.g. soils) and land use change emissions are also included in the Local Authority data. The remainder of the UK emissions such as off shore emissions from oil and gas extraction, fishing and coastal shipping, are reported as unallocated because these could not be spatially disaggregated to LA level.

Sector	CO_2 Emissions ktpa
Domestic	572
Industry & Commercial	472
Road Transport	262
Land Use Change	0
Total	**1306**

Table 31: CO_2 emissions by sector for Waltham Forest (Defra 2003)

The DTI electricity consumption data used in this work is an experimental dataset published for the first time. Electricity used by railways is included in the Industrial and Commercial dataset from DTI. Because it

is not possible to separate rail use of electricity from this data both diesel and electric emissions from the rail sector are allocated to commercial and industrial sector.

The gas data published by DTI provides estimates of gas consumption by the domestic sector and the industrial and commercial sector for each Local Authority in Great Britain, has been used for this report. The estimates have been compiled by DTI using data provided by National Grid Transco (NGT) at postcode sector level. DTI have allocated each postcode sector in the NGT dataset to one or more Local Authority (LA) area.

9.4 Comparison with other London Boroughs

SEA/Renue has compiled a list of emissions for all London Boroughs using the datasets described above with a ranking calculated from the average ranking according to the various datasets (see Appendix 11). This indicates that Waltham Forest has the 7th lowest overall CO_2 emissions of the 33 boroughs and the 4th lowest per capita emissions.

However, the Defra emissions datasets indicate that the per capita domestic emissions are the same as the average per capita domestic emissions for Greater London.

10 Appendix: Thematic maps

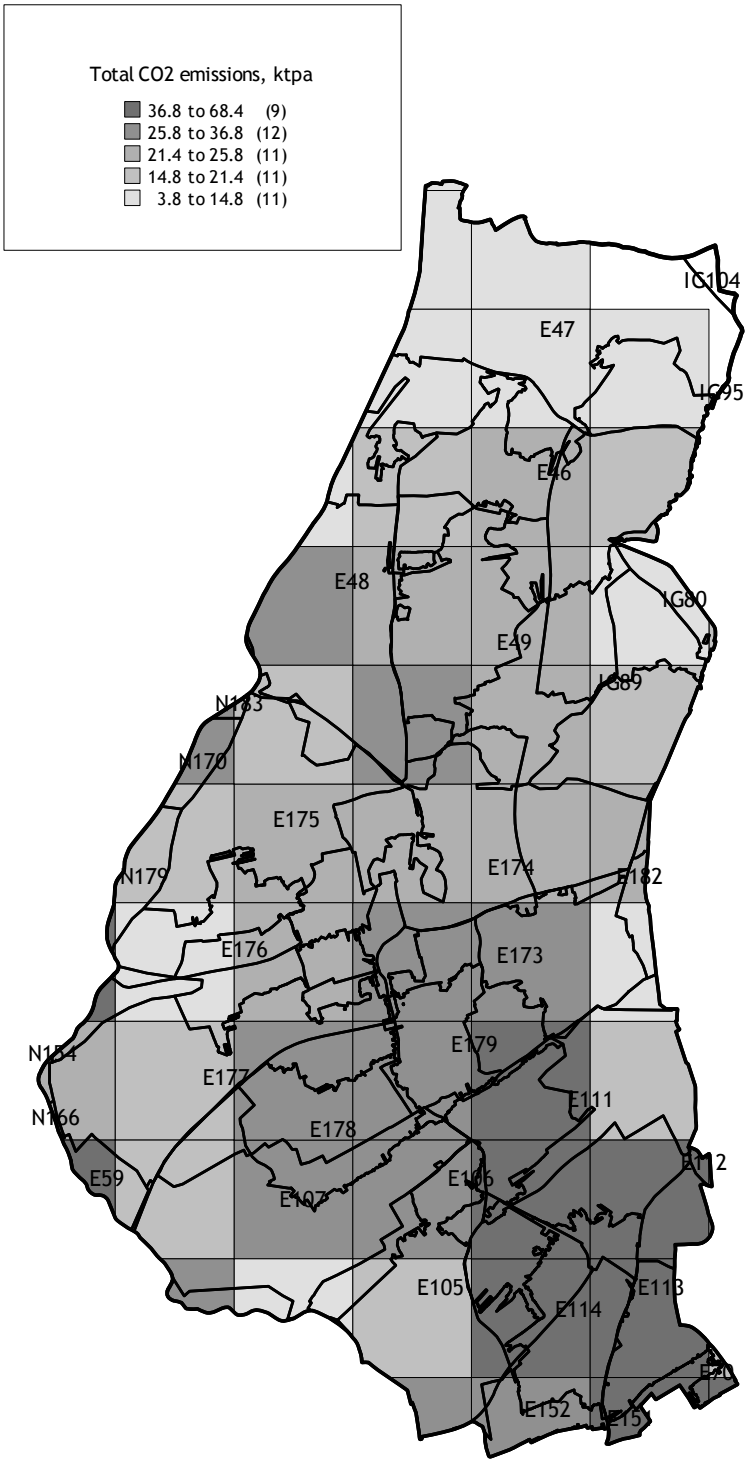


Figure 15 CO_2 emissions (kt/km^2), all sectors

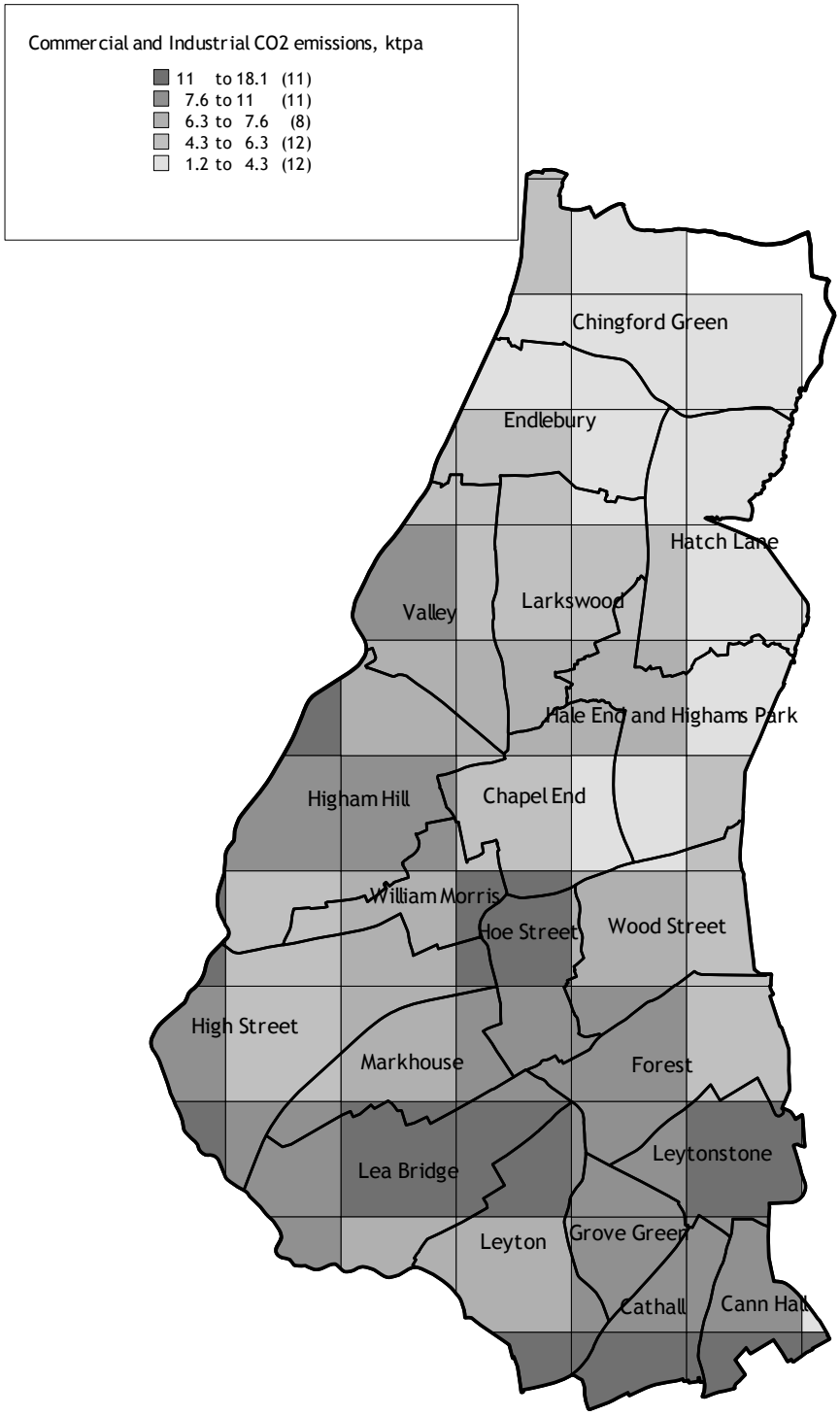


Figure 16 CO_2 emissions (kt/km^2), non domestic buildings

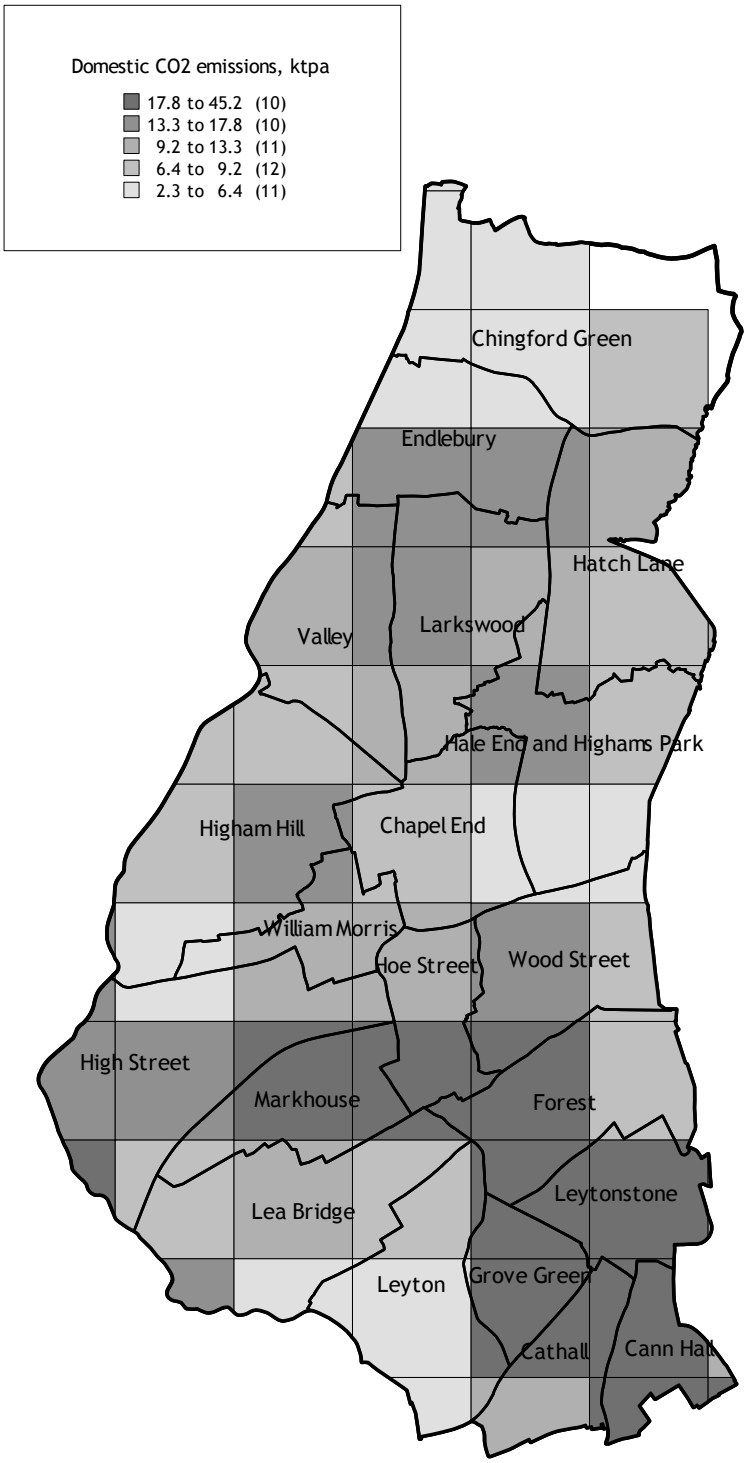


Figure 17 CO_2 emissions (kt/km^2), domestic buildings

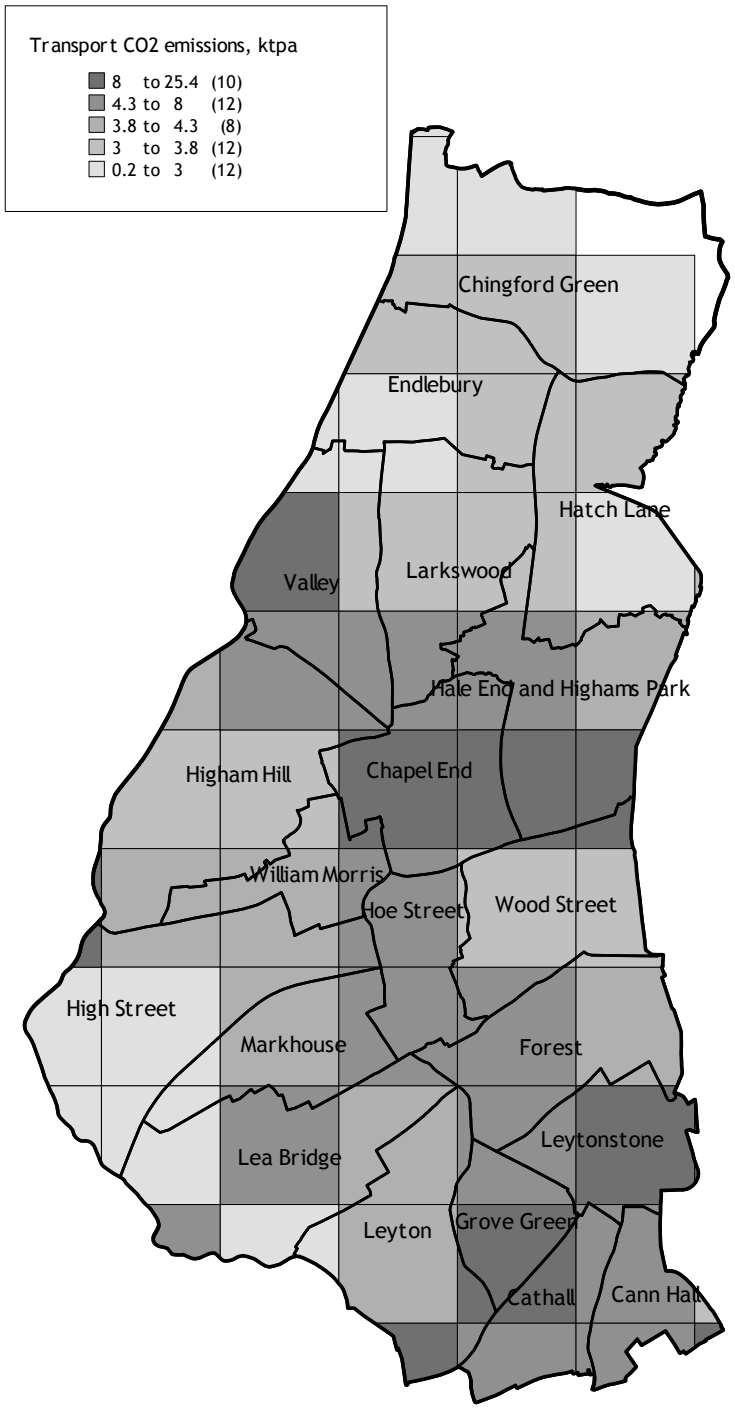


Figure 18 CO_2 emissions (kt/km^2), transport

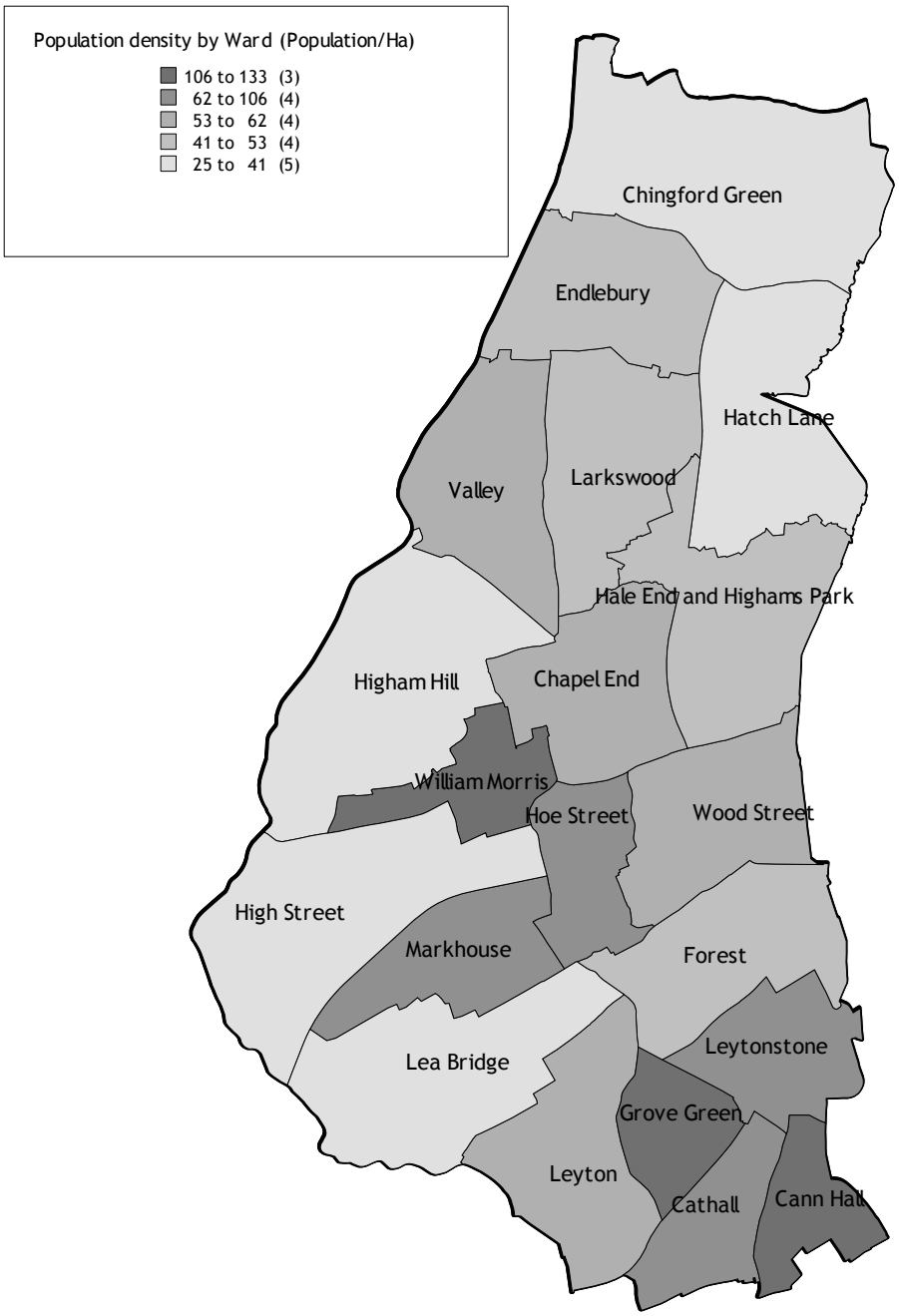


Figure 19 Population density (population/Ha) by ward

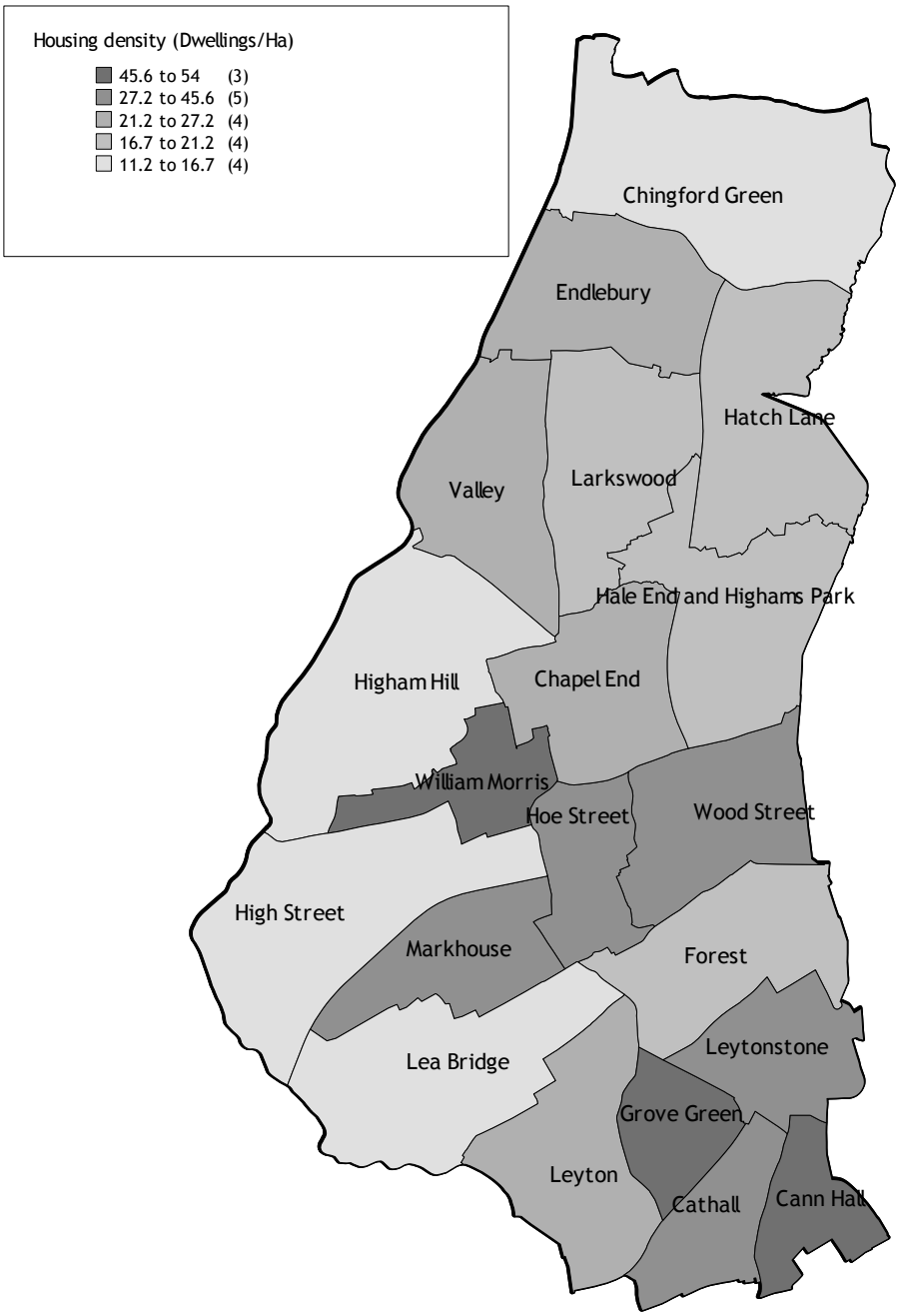


Figure 20 Housing density (dwellings/Ha) by ward

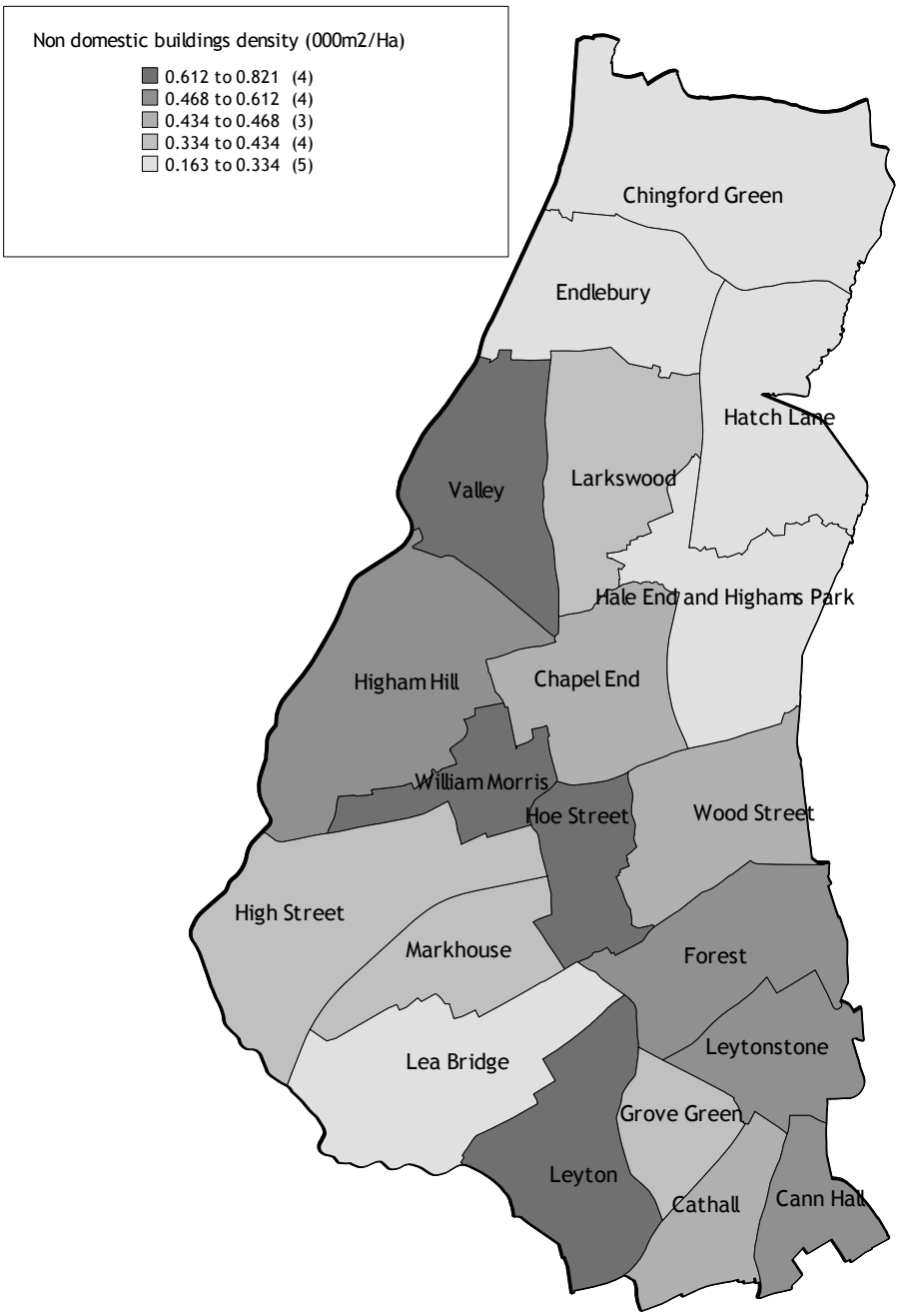


Figure 21 Non domestic buildings density (000 m^2/Ha)

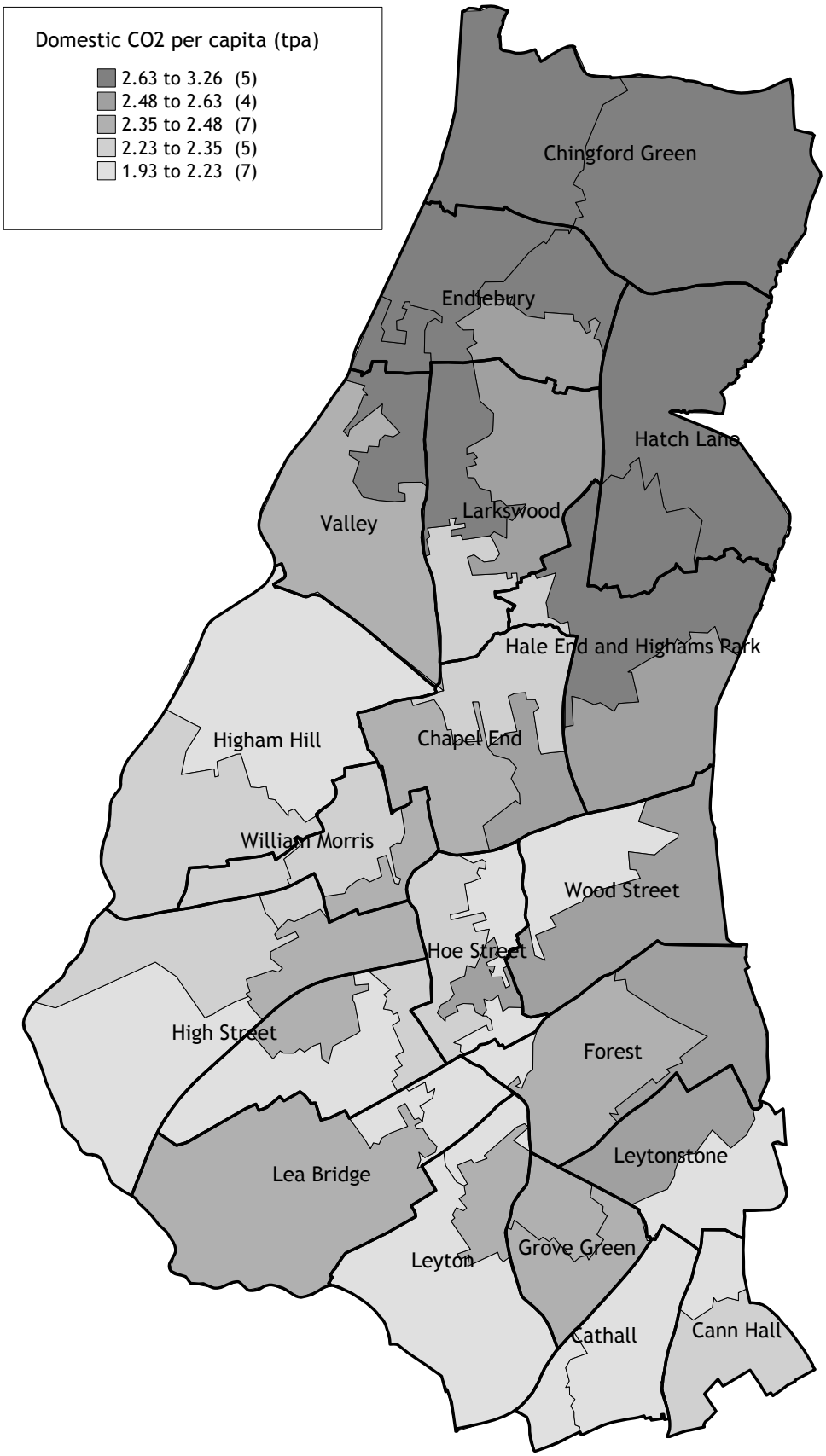


Figure 22 Domestic CO_2 per capita by SOA

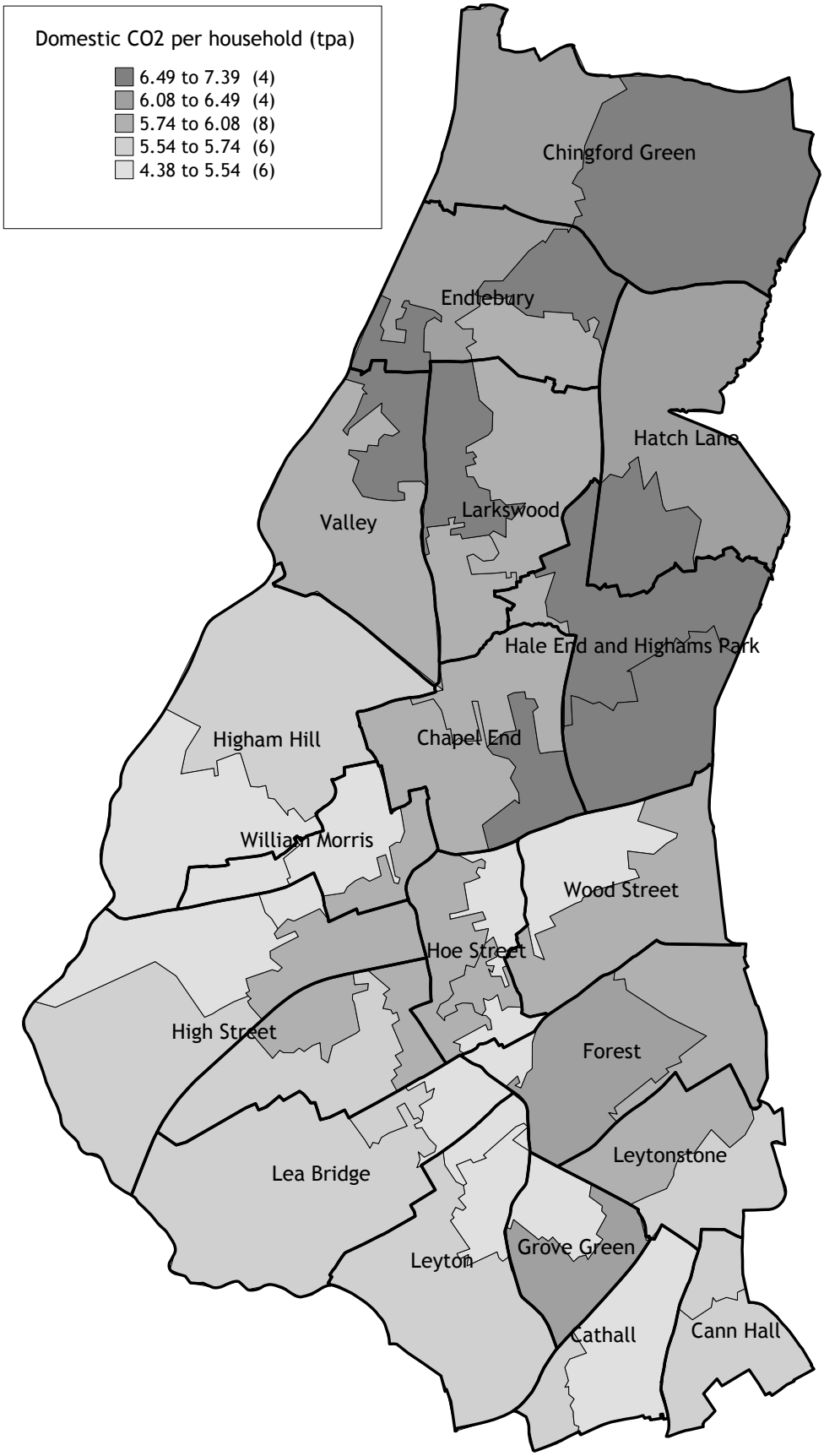
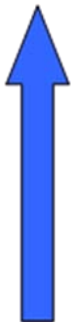


Figure 23 Domestic CO_2 per household by SOA

11 Appendix: Borough emissions ranking

Lower emissions



Ranking by total CO_2 emissions		Ranking by CO_2 emissions per capita		Ranking by CO_2 emissions per area of land	
Barking and Dagenham	1	Hackney	1	Bromley	1
Hackney	1	Lewisham	2	Havering	2
Kingston	3	Redbridge	2	Enfield	3
Sutton	4	Waltham Forest	4	Richmond	4
Merton	5	Haringey	5	Hillingdon	5
Harrow	6	Harrow	5	Croydon	6
Hammersmith and Fulham	7	Barking and Dagenham	7	Barnet	7
Waltham Forest	7	Merton	8	Harrow	8
Haringey	9	Sutton	9	Sutton	9
Richmond	10	Brent	10	Redbridge	10
Redbridge	11	Ealing	11	Bexley	11
Lewisham	12	Lambeth	12	Kingston	12
Islington	13	Croydon	13	Barking and Dagenham	13
Greenwich	14	Wandsworth	14	Merton	14
Kensington and Chelsea	14	Enfield	15	Waltham Forest	15
Havering	16	Bromley	16	Greenwich	16
Bexley	17	Kingston	17	Hounslow	17
Brent	18	Barnet	18	Ealing	18
Camden	19	Havering	18	Brent	19
Lambeth	20	Greenwich	20	Lewisham	20
Wandsworth	21	Newham	21	Haringey	21
City of London	22	Bexley	22	Newham	22
Newham	22	Richmond	23	Wandsworth	22
Enfield	24	Hammersmith and Fulham	24	Hackney	24
Hounslow	25	Camden	25	Lambeth	25
Ealing	26	Southwark	25	Southwark	26
Bromley	27	Islington	27	Camden	27
Southwark	28	Hounslow	28	Hammersmith and Fulham	27
Croydon	29	Kensington and Chelsea	29	Islington	29
Barnet	30	Hillingdon	30	Tower Hamlets	30
Tower Hamlets	31	Tower Hamlets	31	Kensington and Chelsea	31
Hillingdon	32	Westminster	32	Westminster	32
Westminster	33	City of London	33	City of London	33

Higher emissions

Table 32 Borough CO_2 emissions ranking

Table 32 above lists the ranking of all London boroughs by CO_2 emissions. These rankings are an average ranking based on emissions from the Defra, DTI and LECI datasets described in Chapter 5. They are expressed in terms of total emissions, emissions per capita and emissions per area of land.

Note that this is not necessarily a measure of efficiency. For example, inner London boroughs tend to have a higher density of buildings and more commercial and industrial emissions which would increase their emissions per capita and per unit land area.

To measure efficiency, the per capita *domestic* emissions and the commercial and industrial emissions per unit C & I floorspace would be better indicators.

The 2004 Defra CO_2 emissions datasets does include the per capita domestic emissions as shown below, compared to an average of 2.4 tpa for Greater London:

Borough	Per capita domestic emissions (tpa)	Ranking
Camden	1.7	1
Newham	1.8	2
Hackney	1.9	3
Lewisham	1.9	4
Barking and Dagenham	2.0	5
Tower Hamlets	2.1	6
Ealing	2.1	7
Wandsworth	2.2	8
Merton	2.3	9
Brent	2.3	10
Hammersmith and Fulham	2.3	11
Hounslow	2.3	12
Lambeth	2.3	13
Greenwich	2.3	14
Southwark	2.4	15
Islington	2.4	16
Waltham Forest	2.4	17
Redbridge	2.4	18
Kensington and Chelsea	2.4	19
Harrow	2.5	20
Bexley	2.5	21
Croydon	2.5	22
Kingston upon Thames	2.6	23
Enfield	2.6	24
Haringey	2.6	25
Havering	2.6	26
Hillingdon	2.7	27
Sutton	2.7	28

Barnet	2.8	29
Bromley	2.8	30
City of London	2.9	31
Richmond upon Thames	3.0	32
Westminster	3.2	33

Table 33 Ranking by per capita domestic emissions (Defra)

	Ranking by total CO_2 emissions		Ranking by domestic CO_2 emissions per capita		Ranking by total CO_2 emissions per capita	
Lower emissions	Barking and Dagenham	1	Barking and Dagenham	1	Waltham Forest	1
	Kingston	2	Ealing	2	Redbridge	2
	Merton	3	Merton	3	Merton	3
	Sutton	4	Brent	4	Harrow	4
	Harrow	5	Hounslow	5	Barking and Dagenham	5
	Waltham Forest	6	Greenwich	6	Brent	6
	Richmond	7	Waltham Forest	7	Ealing	7
	Redbridge	8	Redbridge	8	Croydon	8
	Greenwich	9	Harrow	9	Sutton	9
	Havering	10	Bexley	10	Bromley	10
	Bexley	11	Croydon	11	Barnet	11
	Brent	12	Kingston	12	Kingston	12
	Ealing	13	Enfield	13	Havering	13
	Enfield	14	Havering	14	Greenwich	14
	Hounslow	15	Hillingdon	15	Enfield	15
	Bromley	16	Sutton	16	Bexley	16
	Croydon	17	Barnet	17	Richmond	17
	Barnet	18	Bromley	18	Hounslow	18
Higher emissions	Hillingdon	19	Richmond	19	Hillingdon	19

Table 34 Comparison of emissions, outer London boroughs

Table 34 above shows the outer London boroughs ranked according to total CO_2 emissions, total per capita emissions and domestic per capita emissions based on Defra 2004 figures. A higher ranking indicates lower emissions. This shows that Waltham Forest has the lowest overall emissions per capita of the nineteen outer London boroughs, the 7th lowest domestic per capita emissions and the 6th lowest total emissions.