The Total Carbon Footprint of Greater Manchester

Estimates of the Greenhouse Gas Emissions from Consumption by Greater Manchester Residents and Industries

A report by Small World Consulting Ltd

Final Report

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An associate company of Lancaster University

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1 Introduction

This report estimates the carbon emissions of Greater Manchester (GM) residents, including not only those resulting directly from energy use but also those resulting from the supply chains of the goods and services that we buy and use. We call this the 'Consumption-based Carbon Footprint', or the 'Total Carbon Footprint'. This is information that has never been seen before. We have also included, in a separate analysis, estimates of the carbon footprints of GM industries, including their supply chains.

Our results raise issues for decision-makers in GM; in section 4, we show how policy-makers can use the footprint breakdown as a policy tool, and then present some outline scenarios to illustrate possible clusters of policy approaches. Additionally, alongside our commentary on the footprint, we highlight some possible approaches,.

You might have seen breakdowns of the area's footprint before but, as stakeholders made clear to us when we presented preliminary findings, for many, the total footprint is a new and important perspective that will take some getting used to.

Therefore, this introduction is devoted to explaining what the Total Carbon Footprint [1]of GM means; and why it is an essential carbon metric. A more technical description is contained in the appendices.

1.1 What does 'total footprint' mean?

The *consumption-based* approach includes supply chain emissions associated with the production of goods and services used and consumed by residents, *wherever those emissions actually take place*. For example, emissions from the production and transport of food purchased by GM residents lie *within* the scope, whereas the footprint of food produced in GM but exported beyond GM's boundaries is *not included* in this analysis. To give another example, in our analysis, the carbon footprint of residents' driving includes not only the direct emissions from their burning of vehicle fuel, wherever that takes place, but also emissions resulting from the extraction, shipping and refining of the fuel, as well as a component for the manufacture of the vehicle itself. It does not, in contrast, include vehicle emissions from non-GM residents who visit the city by car.

1.2 Why should we measure and act on the total footprint?

Until now, official place-based carbon metrics have taken a *production-based* approach, including only direct emissions and those resulting from electricity use. This has had policy implications, since what we measure tends to be what we manage. As a result, central, regional and local government have concentrated on carbon policies concerned almost solely with transport, household energy, energy generation and on-site business emissions.

Relying entirely on the incomplete picture presented by production-based carbon metrics has been a major barrier to strategic approaches for developing low-carbon futures. The adoption of a consumption based metrics alongside production-based accounting opens up a wealth of both opportunity and challenge. Doing so is particularly important when seeking to understand and manage the impacts of lifestyles and of service economies, since in these cases, supply chain emissions often dwarf the direct emissions that would be included in an assessment of only direct emissions.

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[1] The term 'carbon footprint' is used as a shorthand to mean all greenhouse gas (GHG) emissions, which are measured in terms of their 'carbon dioxide equivalent' (CO2e)

Production-based metrics incentivise reductions in direct emissions, blind to any resultant increases in indirect emissions elsewhere. Hence, using production-based measures, the UK's footprint fell by 19% between 1990 and 2009, whereas the consumption-based measures reveal a significant increase over this period. With increasing understanding of indirect carbon, the status quo is unlikely to last at local, national or international levels.

1.3 The benefits for Greater Manchester

The consumption-based analysis gives us a framework for policy development:

- current carbon reduction policies (and other policies and trends which have a carbon impact) can be mapped onto the framework. This enables us to see which segments are not yet addressed as well as those that are.
- by differentiating between 'supply-side' issues (such as energy and resource efficiency) and demand-side issues (chiefly behavioural), a detailed, nuanced understanding is possible; we have a starting point for imagining, and working towards, a genuinely low carbon place.
- It is possible to model the impact of trends and initiatives in a holistic way. For example, developing local supply chains would have a positive impact on emissions in many segments of the footprint.

Consumption-based analysis puts GM in a position to anticipate policy developments:

- Comprehensive local responses to climate change are a relatively new development. GM is currently working with the Department for Energy and Climate Change (DECC) to pilot methodologies for a Local Carbon Framework approach. A place- and consumption-based policy framework is some years away, and GM is in a position to establish the template. Only a handful of authorities have this perspective on their radar.
- At city level, the Mayor of London has committed to "establish a methodology to measure London's Scope 3[2] emissions". Acting on its measurement would put GM at the vanguard among UK cities.
- National policy has also begun to recognise consumption emissions: the Coalition Government's Carbon Plan commits to gather evidence on this, and act on the most significant categories of emission, where UK consumption creates emissions elsewhere.

While the consumption footprint is an essential carbon metric for the demand side of carbon management, production/territorial measures remain important for a number of purposes, including transport planning and energy generation policy.

1.4 A best estimate

This report sets out to provide a broad perspective on the carbon issues and to clarify, in broad terms, the priorities from a carbon management perspective. The figures contained are best estimates.

Even where accurate data is available, all carbon footprints that seek to include supply chain emissions almost always contain considerable uncertainty. This report also relies upon estimates of consumption based on a range of data and assumptions linking that data to emissions estimates. (For more detail see the Methodology section in Appendix A).

[2] Scope 3 emissions are indirect 'supply chain' emissions, as distinct from Scope 1 emissions (direct) and Scope 2 (from power stations to generate energy used in the area being assessed)

2 The carbon footprint of Greater Manchester residents

2.1 Overview

The annual carbon footprint of GM residents is estimated at 41.2m tonnes CO_2e[3]. This makes the footprint of the average resident 15.7 tonnes, roughly in line with that of the average UK resident.

GM resident's footprint breaks down as follows:

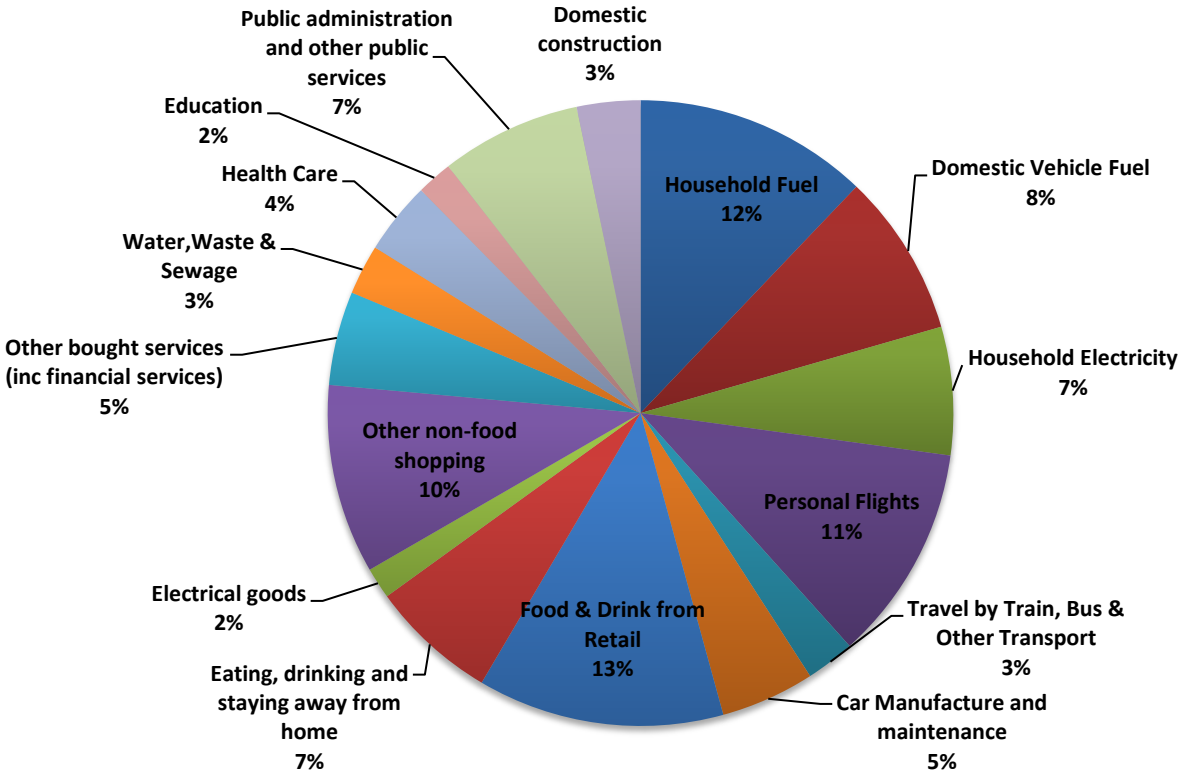

Figure 1: The greenhouse gas footprint of Greater Manchester residents broken down by consumption category (total 41.2 million tonnes CO_2e).

Category	Bolton	Bury	Man.	Oldham	R'dale	Salford	S'port	T'side	Trafford	Wigan	GM
Household fuel	533,007	382,198	746,289	425,046	401,677	406,003	604,249	423,128	475,264	592,216	4,989,076
Domestic vehicle fuel	358,115	284,495	414,332	263,976	257,057	254,610	508,067	278,284	415,065	433,025	3,467,025
Household electricity	280,966	193,648	495,168	207,268	205,915	257,749	308,716	219,413	241,137	313,989	2,723,970
Personal flights	465,109	258,286	1,082,870	342,864	243,864	410,498	680,946	237,817	409,180	472,366	4,603,801
Travel by train, bus & other	107,750	75,462	180,796	81,207	78,618	84,003	130,595	78,297	103,812	119,265	1,039,805
Car manufacture & maintenance	204,120	167,025	217,303	140,994	141,279	134,293	327,137	146,436	278,185	240,703	1,997,475
Food & drink from retail	532,985	370,213	974,097	435,329	409,975	448,674	582,604	427,814	447,461	614,013	5,243,164
Eating, drinking & staying away	281,970	194,223	467,800	212,999	206,082	218,126	337,719	205,385	268,997	308,770	2,702,071
Electrical goods	67,422	48,193	119,354	54,051	51,855	55,462	77,277	52,293	60,783	77,303	663,994
Other non-food shopping	415,889	284,380	726,235	327,858	311,225	336,649	471,834	319,281	366,753	465,734	4,025,839
Other bought services (inc. financial)	203,181	143,201	359,844	163,503	156,527	167,851	231,112	157,963	180,450	232,163	1,995,796
Water, waste & sewage	109,758	73,226	203,293	89,589	82,632	93,128	113,367	89,003	85,547	125,017	1,064,560
Healthcare	158,980	107,823	279,531	126,602	121,052	128,871	179,589	122,154	138,040	178,544	1,541,187
Education	92,418	50,946	108,471	48,885	48,970	50,988	126,682	45,763	105,796	79,544	758,464
Public admin. & other public services	284,775	217,100	518,160	238,887	231,984	242,129	362,721	219,635	336,850	333,255	2,985,495
Construction	137,666	97,172	241,129	110,499	106,588	113,310	157,643	105,581	123,442	156,453	1,349,483
Total	**4,234,112**	**2,947,590**	**7,134,675**	**3,269,557**	**3,055,300**	**3,402,345**	**5,200,261**	**3,128,245**	**4,036,761**	**4,742,358**	**41,151,204**

Table 1: Breakdown of the total footprint for each district

[3] CO_2e: The global warming potential of all the Kyoto greenhouse gases expressed as carbon dioxide equivalent over a 100 year timescale.

Just over a quarter (27%) is down to fuel use in homes and cars. Other transport related emissions (flights, public transport and the carbon embodied in cars themselves) add a further 19%, so that household energy and transport between then make up almost half (46%) of the total carbon footprint.

The rest of the footprint is a mixture of embodied carbon in goods (food as well as all inedible items), a wide range of services (from hotel accommodation to financial services) and public services such as education, healthcare, defence and government. The building, maintenance and improvement of homes accounts for about 3% of the total.

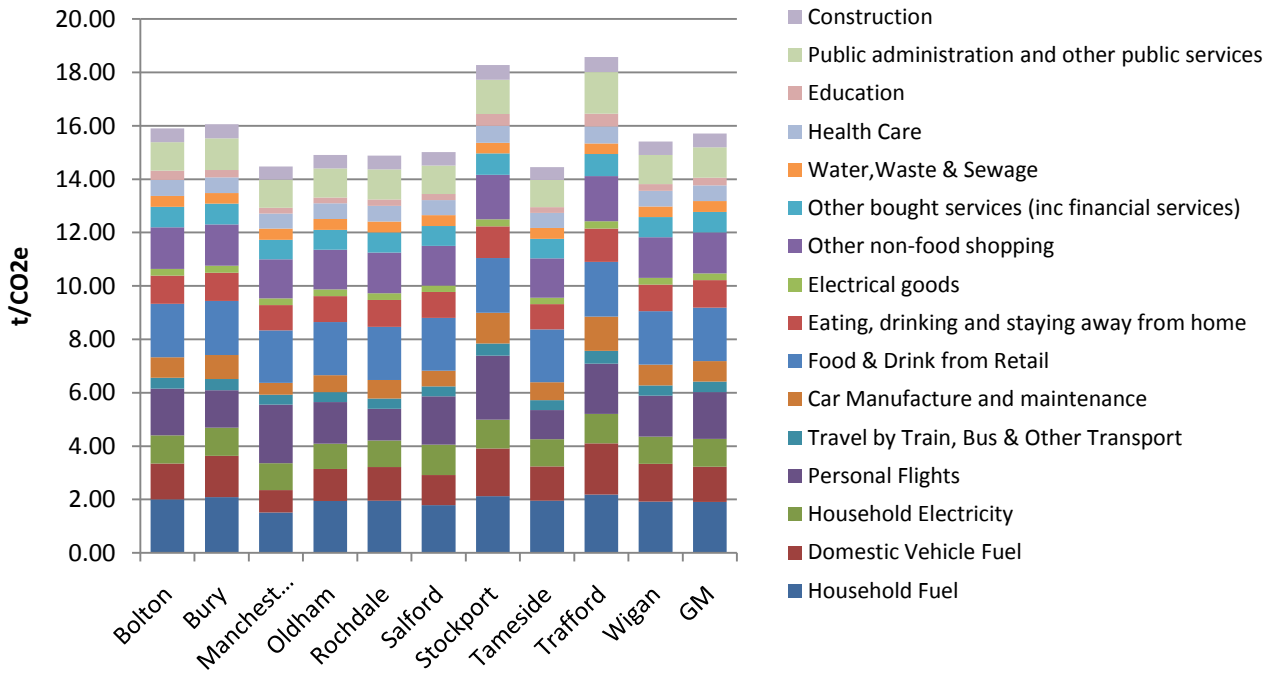

Figure 2: Average annual greenhouse gas footprint per resident by local authority area and consumption category (tonnes CO_2e).

Categories	Bolton	Bury	Man.	Oldham	R'dale	Salford	S'port	T'side	Trafford	Wigan	GM
Household fuel	2.00	2.08	1.51	1.94	1.96	1.79	2.12	1.96	2.19	1.92	1.90
Domestic vehicle fuel	1.35	1.55	0.84	1.20	1.25	1.12	1.79	1.29	1.91	1.41	1.32
Household electricity	1.06	1.06	1.00	0.94	1.00	1.14	1.08	1.01	1.11	1.02	1.04
Personal flights	1.75	1.41	2.20	1.56	1.19	1.81	2.39	1.10	1.88	1.54	1.76
Travel by train, bus & other	0.40	0.41	0.37	0.37	0.38	0.37	0.46	0.36	0.48	0.39	0.40
Car manufacture & maintenance	0.77	0.91	0.44	0.64	0.69	0.59	1.15	0.68	1.28	0.78	0.76
Food & drink from retail	2.00	2.02	1.98	1.98	2.00	1.98	2.05	1.98	2.06	2.00	2.00
Eating, drinking & staying away	1.06	1.06	0.95	0.97	1.00	0.96	1.19	0.95	1.24	1.00	1.03
Electrical goods	0.25	0.26	0.24	0.25	0.25	0.24	0.27	0.24	0.28	0.25	0.25
Other non-food shopping	1.56	1.55	1.47	1.49	1.52	1.49	1.66	1.48	1.69	1.51	1.54
Other bought services (inc. financial)	0.76	0.78	0.73	0.75	0.76	0.74	0.81	0.73	0.83	0.75	0.76
Water, waste & sewage	0.41	0.40	0.41	0.41	0.40	0.41	0.40	0.41	0.39	0.41	0.41
Healthcare	0.60	0.59	0.57	0.58	0.59	0.57	0.63	0.56	0.64	0.58	0.59
Education	0.35	0.28	0.22	0.22	0.24	0.23	0.45	0.21	0.49	0.26	0.29
Public admin. & other public services	1.07	1.18	1.05	1.09	1.13	1.07	1.27	1.01	1.55	1.08	1.14
Construction	0.52	0.53	0.49	0.50	0.52	0.50	0.55	0.49	0.57	0.51	0.52
Total	**15. 91**	**16. 06**	**14. 47**	**14. 91**	**14. 89**	**15. 02**	**18. 27**	**14. 46**	**18. 58**	**15. 41**	**15. 71**

Table 2: Per capita emissions from resident consumption for each district (tonnes CO_2e).

There are significant differences between districts, with residents of Manchester City and Tameside each having an average footprint of 14.5 tonnes CO_2e while the average in Trafford is 18.6 tonnes. There are also significant differences between districts in the profile of these emissions. We estimate that personal flights add 2.4 tonnes CO_2e per person to the footprint of Stockport residents and 2.2 tonnes CO_2e to the footprint of Manchester City residents but only 1.1 and 1.2 tonnes to the Tameside and Rochdale averages respectively. Manchester City has the lowest household and vehicle fuel consumption by a considerable margin.

There is relatively little variation in electricity consumption between districts compared to ratios of more than a factor of two between the highest and lowest per capita flight and driving emissions.

2.2 Detailed composition of the footprint

Our thoughts on carbon management are separated from the main text using italic boxed text.

2.2.1 Household Energy (19% of total footprint)

Household energy accounts for 19% of the total; of this, 65% is from domestic fuel use (mainly gas) and 35% is from electricity. The important household energy management agenda is already well understood; we therefore do not expand on it in this report. Figure 3 shows significant differences between districts.

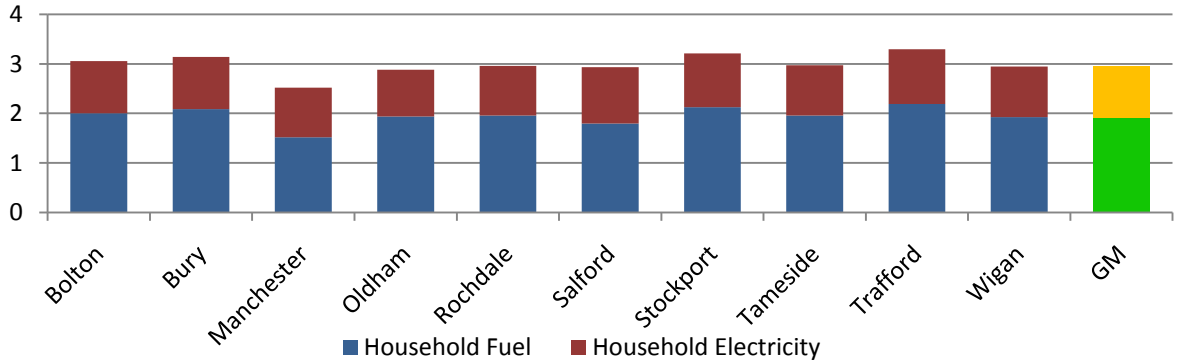

Figure 3: Average annual greenhouse gas footprint per resident from household fuel and electricity by local authority area (tonnes CO_2e).

2.2.2 Driving (13% of total footprint)

This category excludes business travel but includes commuting. All driving by residents is included even when this takes place outside of Greater Manchester, but visitor driving is not included. The footprint of driving includes vehicle fuel (8% of the total) and also the manufacture and maintenance of cars (5% of the total), taking the total footprint of driving to 13% of the total resident footprint. Around three quarters of the emissions from the fuel come directly out of car exhaust pipes, with the other quarter arising from the fuel supply chains of extraction, transport and refining. Overall therefore, exhaust pipe emissions account for only about half of the footprint of driving.

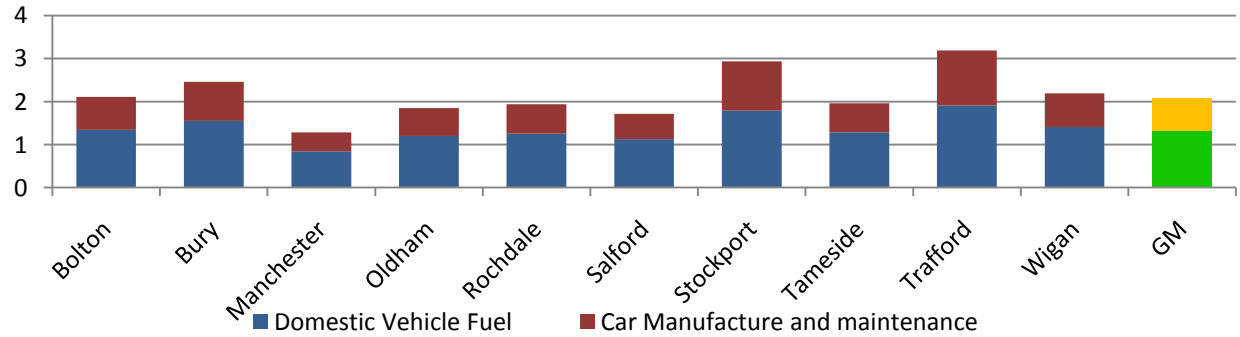

Figure 4: The greenhouse gas footprint of driving for residents in each district (tonnes CO_2e per capita).

There are very significant differences between districts with, for example, Manchester city residents driving less than half as much as Trafford residents.

Within Greater Manchester, driving could be reduced through improvements in the infrastructure for walking, cycling and public transport, and developing cultures of home working, lift sharing and careful driving. There is evidence that taking one car out of a traffic jam has about twice the carbon benefit that most people expect as it cuts both the emissions from that car and, of roughly equal significance, cuts the emissions from the other cars in the jam by reducing the level of congestion that they all experience. Promoting local leisure stands to cut car travel whilst benefitting the local economy. High quality vehicle maintenance stands to reduce both the embodied carbon in vehicles per mile and the vehicle fuel efficiency. Electric cars stand to deliver carbon efficiency improvements along with cleaner, quieter streets.

2.2.3 Flights (11% of total footprint)

This category includes leisure flights but not business flights or air freight, (which are attributed to the goods and services of the businesses for whom the flights take place). There is significant difference in the flights per capita by district. For the people of Stockport, flying accounts for 2.4 tonnes CO_2e per person and is 11% of their total footprint, compared with 1.1 tonnes CO_2e per person in Tameside, less than 10% of their total. This suggests that ease of access to Manchester Airport might be to be a factor in determining personal flight emissions.

This report does not seek to comment on the economic and social importance of air travel, nor on the weighting of these factors alongside environmental considerations. However, in the interests of high quality decision making we present the carbon perspective so that trade-offs can be clearly and transparently understood by all parties.

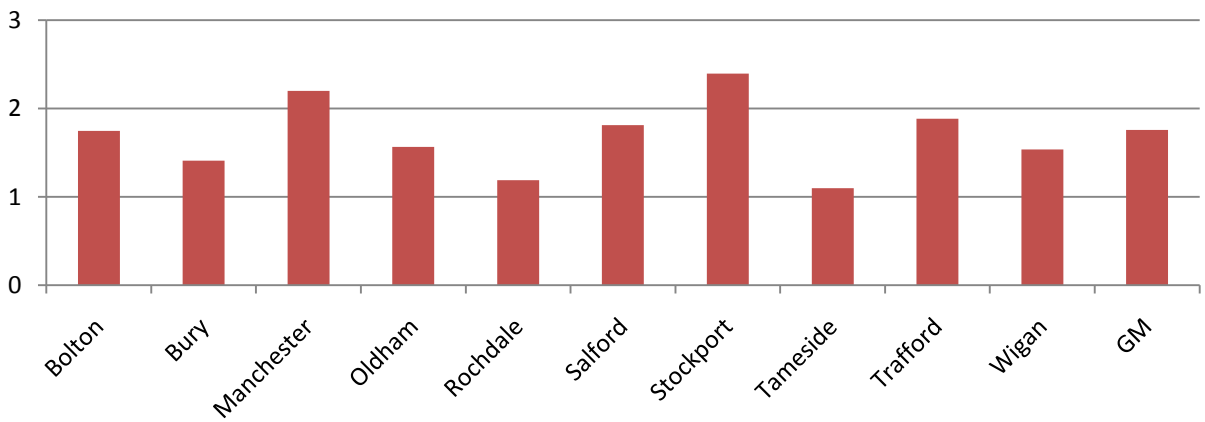

Figure 5: The greenhouse gas footprint of aviation for residents in each district (tonnes CO_2e).

2.2.4 Food and drink from retail (12%)

Food and drink from retail does not include that purchased from restaurants, cafes, pubs, hotels or that consumed by industry (for example in business lunches) or through the delivery of public services, such as school and hospital meals. Nor does it include emissions resulting from the cooking or wasting of food[4]. If all these components are added on, food accounts of around 20% of the total footprint. Some analyses suggest

[4] The emissions resulting from cooking are represented in 'household fuel' and 'household electricity'. Those from waste appear in the 'water, waste and sewerage' category.

that if emissions changes in land–use resulting from food demand are taken into account, food should be considered to be around 30% of the UK's greenhouse gas footprint[5].

Our analysis of differences between regions was based on socio-economic analysis and showed less than 5% difference between the highest and lowest districts. Two factors account for this. Firstly, whilst there is evidence that wealthy households have somewhat more carbon intensive diets, the difference is less than proportional to the wealth difference. Secondly, each district taken as a whole contains a wide, and in broad terms, similar socio-demographic mix.

The two most critical factors in determining the footprint of food are diet and waste. As a broad generalisation, the highest carbon diets are those with high meat and dairy contents, especially where there is high red meat content and most all where the red meat is from ruminants (cows and sheep). Other factors in high carbon diets are the purchase of out-of-season produce (dependent on hot-housing or airfreight) and excessive packaging (although some packaging is beneficial in helping to reduce waste).

The average UK person is thought to waste around a quarter of the edible food that they purchase[6] and reducing this presents a clear opportunity to improve household prosperity whilst cutting the carbon.

Food miles by boat are not usually an important factor in the footprint of foods and nor are road miles the dominant issue. However, local fruit and vegetables, when in season, are likely to have the best carbon credentials as well as benefitting the local economy and, potentially, strengthening consumers' sense of connection between what we eat and how it is produced.

Focussing on dietary change and waste reduction in lower income households and students may deliver important health and prosperity benefits alongside carbon savings.

2.2.5 Eating, drinking, staying and recreation away from home (6% of total)

This includes hotels, pubs, restaurants, cafes and leisure facilities. Around half the emissions in this category stem from food. Whilst the carbon in food bought from shops is similar per person between districts, our analysis, based on socio economic data and family expenditure surveys suggests greater differences between districts in this category.

The most important considerations for carbon efficiency in hotels are low carbon food (menus, portion control and minimising kitchen waste), energy efficiency and low carbon procurement. Customers can support and influence this through their buying decisions.

[5] Audsley, E., Brander,M., Chatterton, J., Murphy-Bokern, D., Webster, C. and Williams, A. (2010) 'How low can we go? An assessment of greenhouse gas emissions from UK food system and the scope for reduction by 2050'. WWF-UK.
[6] WRAP (2008) 'The Food We Waste' Waster & Resources Action Programme(WRAP), Banbury. Available on request at <http://www.wrap.org.uk/retail_supply_chain/research_tools/research/report_household.html>

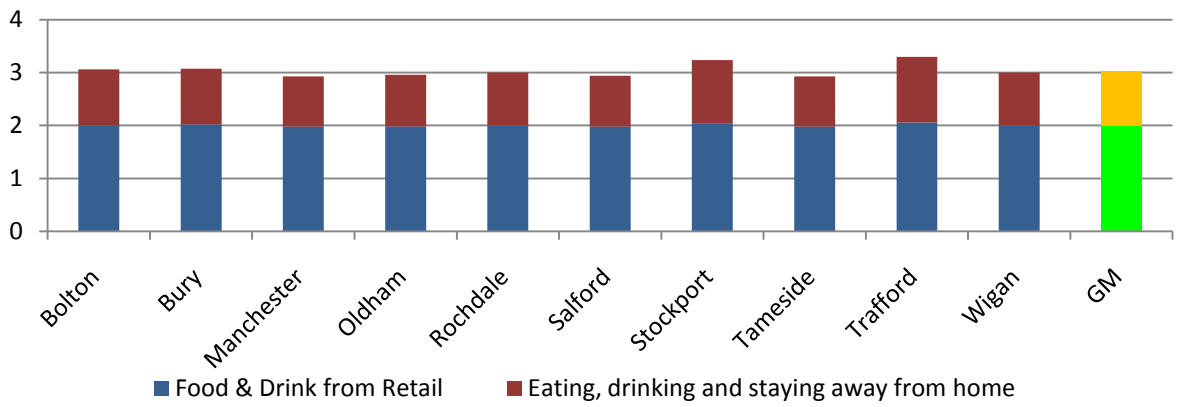

Figure 6: The greenhouse gas footprint of food and drink for residents in each district (tonnes CO_2e).

2.2.6 Non food shopping (11% of total)

This category includes a wide variety of goods. Some key components are worth noting:

- Electrical goods (1.6% of total),
- Clothing and footwear (1.4%),
- Furniture, carpets and other household textiles (1.0%),
- Books, paper and published materials (0.8%),
- Soaps and toiletries and pharmaceuticals (0.7%),
- Jewellery (0.4%).

UK emissions targets do not take account of greenhouse gasses embodied in imported goods; this omission perversely incentivises imports over UK manufacturing, even though this is very often more carbon intensive[7].

A lower carbon culture and economy might include the habits and business infrastructure to support second hand markets and the repair and maintenance of goods of every kind; it would also inevitably involve developing approaches to 'collaborative consumption', such as car clubs and 'swishing'[8]. In addressing this part of the footprint there are opportunities for households to be better off, for relevant businesses to thrive and for the reduction of waste. The carbon footprint of goods also depends partly on the levels of recycling of materials.

2.2.7 Healthcare (3.7%)

Whilst energy consumption is considerable, the carbon footprint of healthcare lies primarily in its supply chains including for, equipment, infrastructure, medical consumables and food.

Health improvement through, for example, increased cycling ,walking and better diets stands to bring about reductions in multiple parts of the footprint as well as delivering wellbeing benefits and reduced healthcare costs.

[7] For example Ecofys (2007) reports electricity in China as 63% more carbon intensive than the UK's as a result of being generated primarily from coal compared to the UK's less carbon intensive mix and emissions per tonnes of steel produced in China being twice that of the UK.

[8] http://swishing.com/

2.2.8 Education (1.8%)

As with healthcare, the footprint lies primarily in the supply chains.

Schools, colleges and universities can fulfil dual roles of carbon saving and education. Whilst saving carbon, there are possibilities to save money through energy and resource efficiency, and even more importantly to educate for carbon-careful consumption. It is important that carbon management initiatives take account of the whole carbon agenda including the indirect emissions behind food and other consumables, goods and services well as the traditional areas of energy use and travel.

2.2.9 Household construction (3.3%)

Around 80% of this is new construction and the rest is maintenance and home improvement.

Reduction of this part of the footprint is not the priority, since the quality with which it is done can have a disproportionately beneficial effect on household energy use. It is highly beneficial to direct disposable household income towards home energy efficiency measures, the benefits from which are typically split between increased comfort and reduced energy use.

Planners have an important role in ensuring sustainable new builds in terms of energy efficiency as well as location and layouts that enable low carbon lives.

2.2.10 Public administration, defence and other public services (7.2%)

Within this part of the footprint are allocations for nationally delivered services such as central government and the armed forces, both of which are outside the control of residents or local government.

The Combined Authority, local authorities and other local public providers have an important role to play in managing their own footprints. Much of this can be aligned with resource efficiency and cost savings, especially through low carbon procurement and energy efficiency.

2.2.11 Water, Waste and Sewage (2.6%)

The majority of the footprint here comes from sewage and waste treatment rather than water supply. The carbon footprint savings from reduction in household water usage are relatively limited, even though these actions are important in their own right, quite apart from the carbon savings.

2.2.12 Other bought services (4.8%)

The largest components of this category are:

- Banking, finance and insurance (1.7%).
- Letting of dwellings (1.7%)
- Telecommunications (0.7%)

These may be difficult parts of the consumption footprint for either residents or local government to take action to reduce.

3 The carbon footprint of Greater Manchester industries

As in the last section, our thoughts on carbon management are separated from the main text using italic boxed text.

3.1 Overview

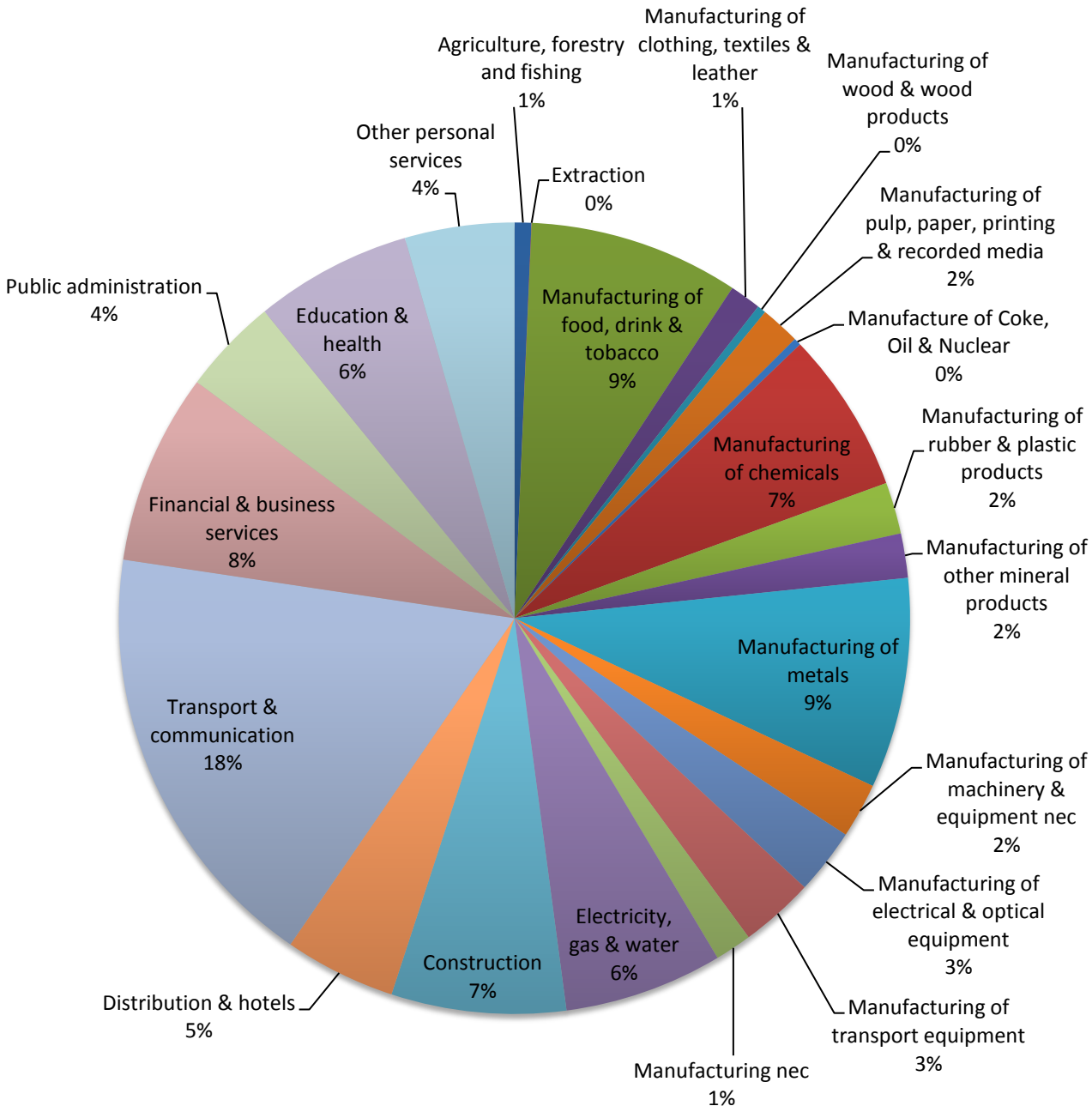

Figure 7: Greenhouse gas footprint of greater Manchester industry broken down by industry category (of total 51.4 million tonnes CO_2e)

We have estimated direct emissions (scope 1), those resulting from electricity use (scope 2) and supply chain emissions (scope 3) for the industry categories used in the Greater Manchester Forecast Model[1]. The sum of these across all industries is 51.4 million tonnes CO_2e per year. Note that there is considerable double counting involved here since direct emissions from one business may fall into the supply chains of one or more other businesses in the geographical area covered. For example, the footprint created by a business executive staying in a hotel will feature in both her company's footprint and that of the hotel. However, when this occurs, there are also multiple opportunities to manage the emissions, either directly, or through supply chain management; and carbon reduction, too, would be 'double counted'. In this way, the total figure gives a sense of the total carbon management opportunity.

There is also overlap between the footprints of industries and the consumption footprint of residents in cases where residents buy the products and services of local businesses. Again, where this occurs there are multiple opportunities for carbon management in GM; through consumption and through industries and their supply chains.

The ten districts contain somewhat different industry mixes and as a result different industry emissions profiles.

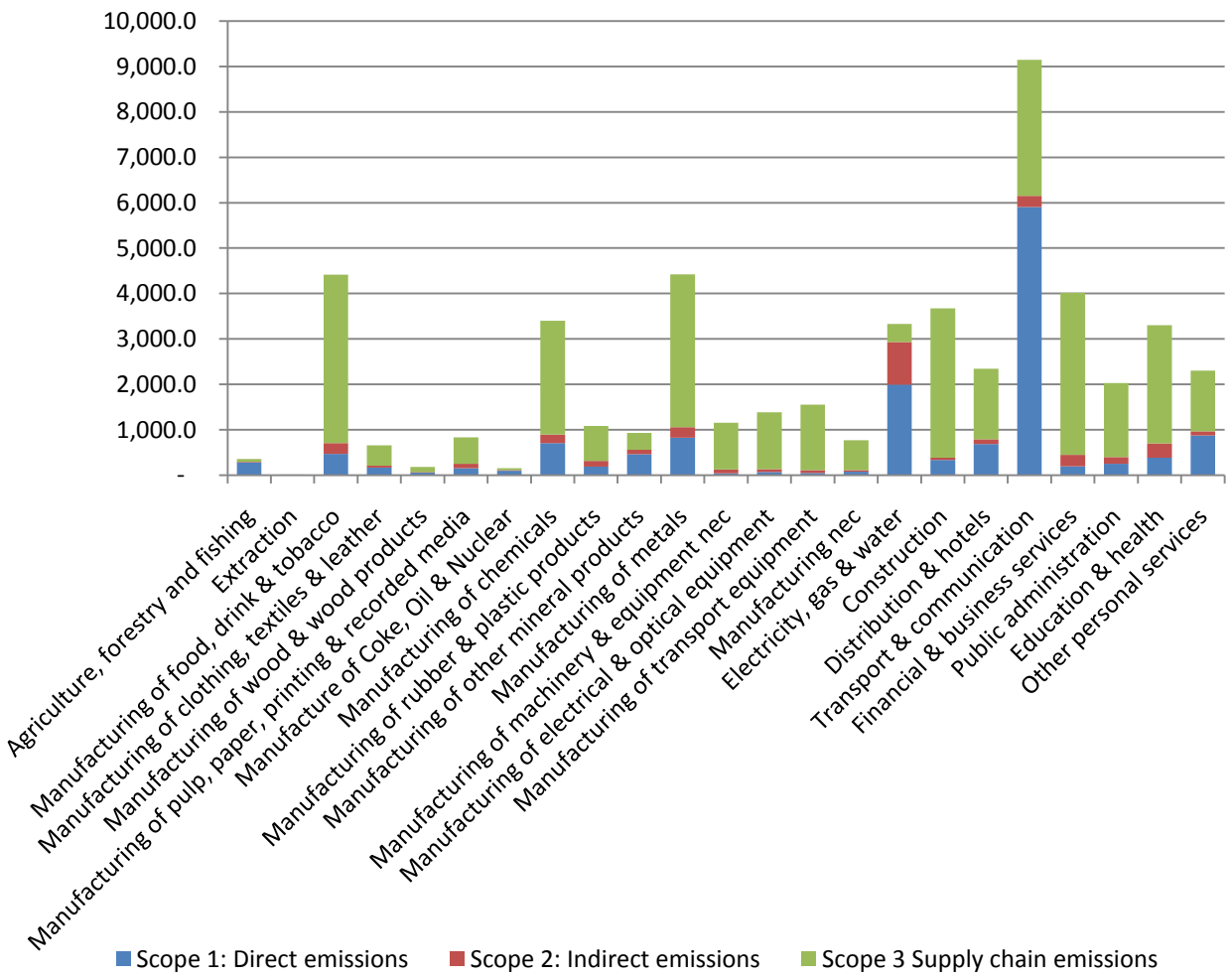

Figure 8: Scope 1, 2, and 3 emissions from industries in Greater Manchester

[1] http://neweconomymanchester.com/stories/1119-greater_manchester_forecasting_model.

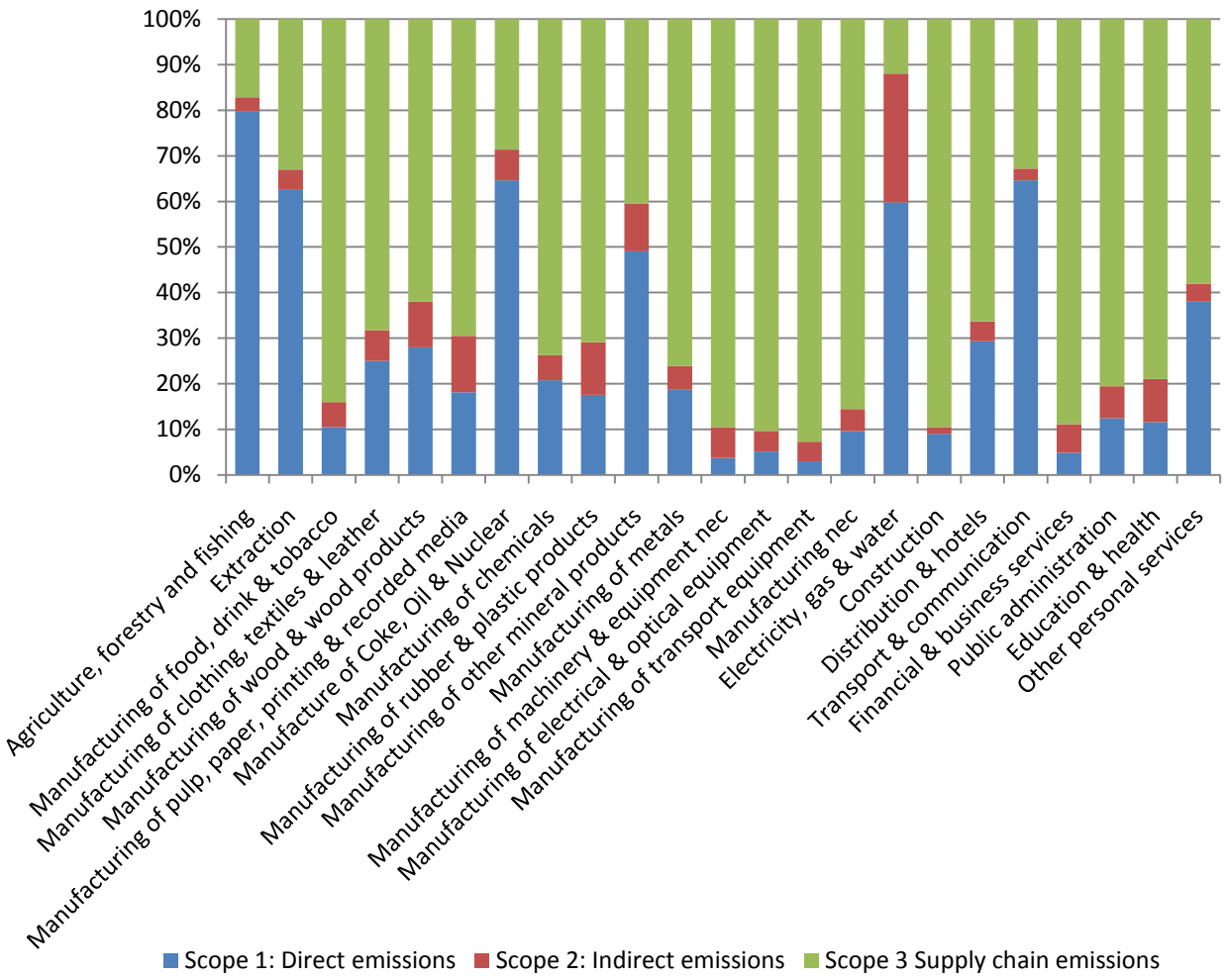

Figure 9: The relative importance of Scope 1, 2, and 3 emissions in different industries.

The split between scope 1, 2 and 3 emissions varies widely between industries. Direct emissions dominate agricultural, extraction and transport businesses, whereas supply chains dominate the footprints of financial and business service industries, healthcare, education and most types of manufacturing. Electricity is a relatively small part of the total footprint for most industries.

Where supply chains dominate the footprint of an industry, carbon management needs to include resource efficiency (with associated cost savings) and low carbon procurement. In many cases, the local sourcing of materials and components is less carbon intensive than importing, since the carbon intensity of overseas manufacturing is often higher than it is in the UK. Whilst it is a generalisation, this is an important message for businesses to understand, especially since low carbon sourcing will often also benefit the local economy. Bringing the low carbon agenda into procurement criteria in a robust but practical way is less complicated than often perceived.

The breakdown of industries used in our estimates is the same used by the Greater Manchester Forecast Model, from which key data was used. However, in the discussion below we use a slightly different categorisation and address the industries for which we have something relevant to contribute.

3.2 Detailed composition of the footprint

3.2.1 Agriculture

A clear majority of emissions take place on the farm, with methane and nitrous oxide playing a more dominant role than carbon dioxide. The carbon implications of different agricultural practices are often highly complex and fraught with scientific uncertainty. To add to the complexity agricultural decisions need to take account of other environmental considerations such as biodiversity and water quality as well as economic considerations.

Despite these difficulties there is often scope for the identification of simple, significant and commercially viable improvements, and in doing so, the focus needs to go beyond direct energy reduction, which, except in the case of hot-housing is generally a minor consideration in farming.

3.2.2 Food manufacturing

The majority of emissions are embodied in the ingredients themselves.

The main carbon management issues therefore are:

- *choice of products and ingredients,*
- *waste minimisation,*
- *energy efficiency and minimising refrigerant gas losses,*
- *sourcing,*
- *packaging optimisation, reuse and recycling.*

The use of seasonal produce reduces the carbon and where this can be locally sourced there are advantages for the local economy as well. Except where air freighting is involved, food transport is not usually a critical carbon issue.

Note that the composting of waste food mitigates against its carbon footprint only to a small degree. The real waste reduction challenge is to ensure that food is eaten by people.

3.2.3 Other manufacturing

The balance of emissions between fuel, electricity and supply chains varies between manufacturing industries but in most cases within Greater Manchester, the majority of emissions lie in the supply chains.

Carbon management emphasis should be on low carbon procurement and resource efficiency. Both these measures stand to deliver cost as well as carbon savings.

3.2.4 Retail

In our carbon accounting we have adopted the convention that the carbon in products sold through retail and wholesale is attributed to the manufacturers of those products rather than to the distributors. However it is important to recognise that if the products are taken into account they dominate the carbon footprint of most retailers.

In the case of food retailers, greenhouse gasses embodied in products typically accounts for around 80-90% of the total footprint[2]. Therefore energy efficiency within retail, whilst important, is only a small part of the carbon management agenda.

There is lot that retailers can do to influence the carbon footprint of consumers. In the case of supermarkets this includes:

- *Emphasising and promoting seasonal, local and other low carbon products.*
- *Not encouraging over-buying of short shelf life products, such as through 'Buy one get one free'.*
- *Increasing the seasonality of their range.*
- *Ensuring that lower carbon foods, such as alternatives to ruminant meat and dairy products are of high quality and well promoted.*
- *Reducing in-store waste especially through good deliveries management. Note that as for food manufacturers, the composting of food waste is not a substitute for ensuring that it is eaten.*
- *Ensuring that high quality information about the carbon in food is available for customers[1].*

Other retailers can similarly play a part, including through such measures as:

- *Focussing on high quality, durable products,*
- *encouraging repair and recycling,*
- *developing second hand markets,*
- *promoting goods which are low carbon in use, such as energy efficient appliances and easy-to-wash clothing.*

3.2.5 Hotels, pubs and catering

Across all UK hotels, pubs and catering services, food and drink represents roughly half of the total carbon footprint, with direct energy use being under a fifth of the total.

The most important considerations for carbon efficiency in hotels are low carbon food (menus, portion control and minimising kitchen waste), energy efficiency and low carbon procurement. The opportunities for cost savings through waste minimization and/or shifts towards seasonal or lower meat menus will often be greater than those achievable from energy savings, provided they can be done in ways that ensure any impacts on the customer experience are also positive.

3.2.6 Education and healthcare

A clear majority of the footprint lies in the supply chains.

It is important that environmental initiatives in schools, colleges and universities take account of the whole carbon agenda. Whilst there are possibilities to save money through energy, the savings potential through green procurement is significantly higher. Even more importantly, there are opportunities to educate for carbon-careful consumption. It is important for educational institutions to understand that carbon literacy critically includes an understanding of the emissions embodied in food, other consumables and goods as well as direct energy and travel. Alongside carbon literacy education, there are opportunities to improve student health and prosperity.

There may be similar educational potential in hospitals. Here, waste reduction also translates into reduced healthcare costs.

[2] In the case of EH Booths the estimate is 87% (Booths 2010).

3.2.7 Financial and business services and public administration

In these and other office based industries, a small proportion of the total footprint is attributable to direct emissions or electricity.

Carbon management in these organisations necessarily involves low carbon procurement and resource efficiency. Low carbon procurement will often mean an increase in local sourcing and resource efficiency translates directly into cost savings for the business. Businesses in these industries have important opportunities to engage their supply chains in carbon management.

3.2.8 Electricity, gas and water

Energy use dominates the footprint of these industries and the issues are well understood prior to this report.

3.2.9 Transport and communication

This group of industries does not include flights themselves but does include airport infrastructure; this represents a very small proportion of the carbon footprint of flying. For other transport industries, direct emissions dominate, although emissions embodied in vehicles are also a significant part of the picture.

There is value in carbon management taking into account embodied carbon in vehicles and infrastructure within these industries whilst being clear, at least in broad terms, about the scale of these emissions relative to direct emissions.

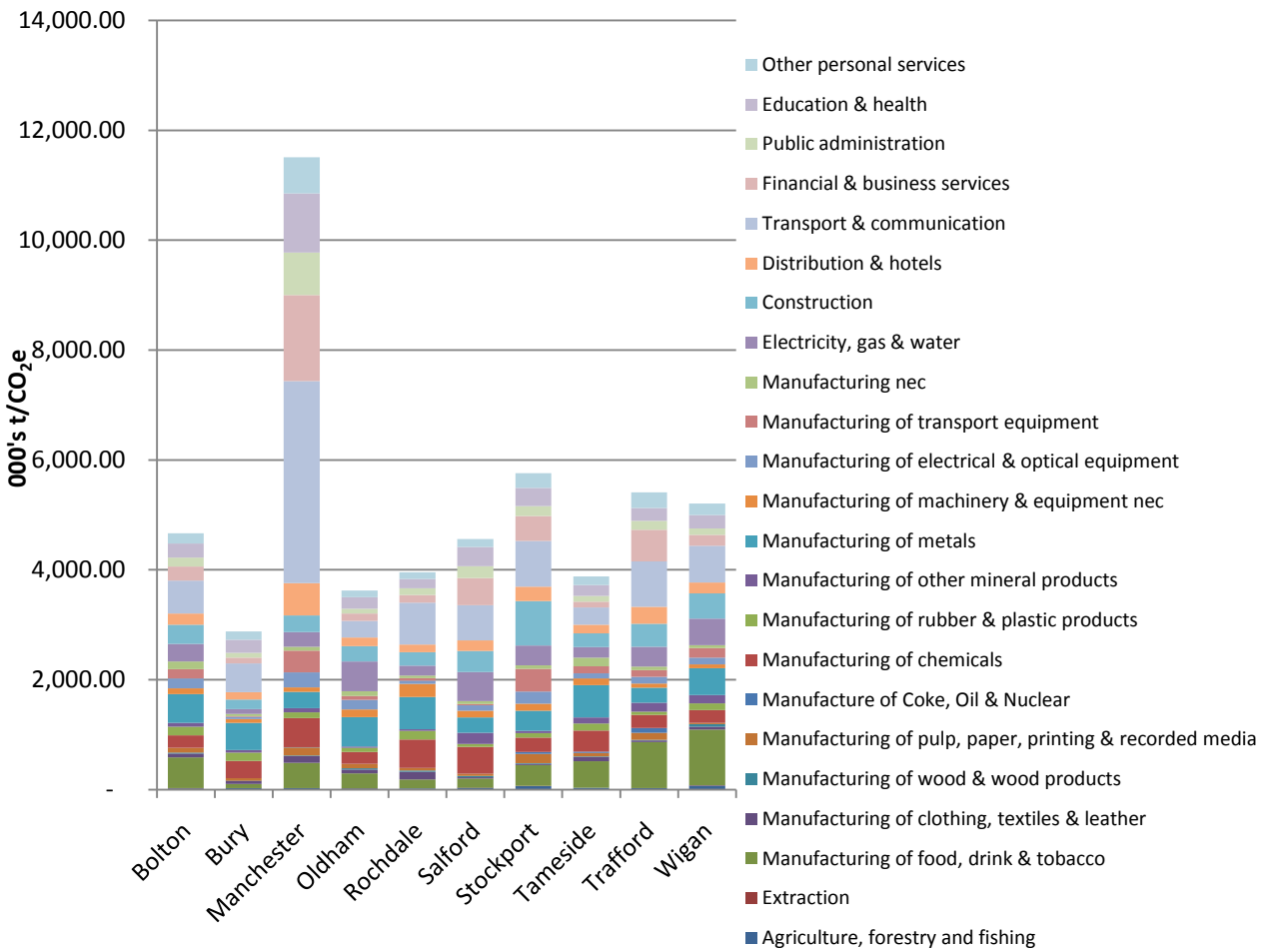

Figure 10: Greenhouse gas footprint of industry by local authority area and industry category (thousand tonnes CO_2e)

	Bolton	Bury	Man.	Oldham	R'dale	Salford	S'port	T'side	Trafford	Wigan	GM
Agriculture, forestry and fishing	23.31	27.85	27.15	18.67	23.81	30.67	63.90	33.02	27.71	76.15	352.25
Extraction	0.97	0.45	0.39	0.10	-	0.05	2.14	-	-	2.14	6.25
Manufacturing of food, drink & tobacco	562.22	76.34	460.19	277.94	160.81	168.01	377.82	483.69	839.89	1,011.61	4,418.53
Manufacturing of clothing, textiles & leather	71.59	53.60	122.26	67.94	140.25	25.38	24.39	73.77	25.53	53.90	658.61
Manufacturing of wood & wood products	12.28	4.91	8.74	24.57	22.11	24.56	12.28	14.74	14.74	44.22	183.15
Manufacturing of pulp, paper, printing & recorded media	90.31	45.50	147.85	79.58	45.85	38.43	170.27	60.50	124.79	28.35	831.43
Manufacture of Coke, Oil & Nuclear	-	-	8.09	-	-	-	32.38	24.28	89.03	-	153.79
Manufacturing of chemicals	223.97	314.47	525.65	215.95	517.00	488.22	260.36	387.27	236.08	233.32	3,402.29
Manufacturing of rubber & plastic products	160.67	150.00	106.03	72.70	156.27	52.97	84.98	123.78	59.57	117.39	1,084.34
Manufacturing of other mineral products	67.12	46.89	77.86	27.12	30.22	208.13	40.90	114.12	164.59	154.34	931.29
Manufacturing of metals	525.24	491.89	296.29	532.62	586.37	274.68	364.19	584.69	274.92	490.22	4,421.11
Manufacturing of machinery & equipment nec	105.56	69.08	78.52	138.67	241.86	122.58	132.10	125.73	72.90	67.91	1,154.90
Manufacturing of electrical & optical equipment	180.20	40.89	275.18	178.03	59.08	98.88	215.85	88.93	123.30	122.43	1,382.76
Manufacturing of transport equipment	166.96	15.86	393.54	69.85	45.14	25.41	416.27	126.87	122.40	172.24	1,554.52
Manufacturing nec	139.22	39.97	72.34	86.38	44.12	50.52	62.01	158.41	61.96	56.25	771.18
Electricity, gas & water	323.76	85.49	267.17	542.55	180.85	531.47	361.70	195.92	361.70	482.27	3,332.89
Construction	350.05	176.87	302.73	276.26	246.12	380.64	812.01	250.49	419.00	455.85	3,670.02
Distribution & hotels	203.36	131.57	585.16	157.53	140.15	195.60	260.02	155.58	310.97	201.63	2,341.57
Transport & communication	598.27	523.60	3,680.21	306.13	763.66	641.72	831.47	312.85	824.50	666.28	9,148.69
Financial & business services	252.03	107.97	1,562.36	129.44	137.48	490.72	454.18	106.68	576.32	198.97	4,016.15
Public administration	165.72	87.76	778.50	90.55	123.62	214.65	181.91	104.65	160.98	119.03	2,027.37
Education & health	257.91	236.92	1,072.85	207.91	170.46	350.57	327.24	196.53	235.19	244.25	3,299.84
Other personal services	186.26	151.49	657.71	120.85	119.44	147.55	267.92	155.19	285.15	206.94	2,298.49
Totals	**4,667.0**	**2,879.4**	**11,506.8**	**3,621.3**	**3,954.7**	**4,561.4**	**5,756.3**	**3,877.7**	**5,411.2**	**5,205.7**	**51,441.42**

Figure 11: Greenhouse gas footprint of Greater Manchester industry (thousand tonnes CO_2e)

	Bolton	Bury	Man.	Oldham	R'dale	Salford	S'port	T'side	Trafford	Wigan	GM
Agriculture, forestry and fishing	0.5%	1.0%	0.2%	0.5%	0.6%	0.7%	1.1%	0.9%	0.5%	1.5%	0.7%
Extraction	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Manufacturing of food, drink & tobacco	12.0%	2.7%	4.0%	7.7%	4.1%	3.7%	6.6%	12.5%	15.5%	19.4%	8.6%
Manufacturing of clothing, textiles & leather	1.5%	1.9%	1.1%	1.9%	3.5%	0.6%	0.4%	1.9%	0.5%	1.0%	1.3%
Manufacturing of wood & wood products	0.3%	0.2%	0.1%	0.7%	0.6%	0.5%	0.2%	0.4%	0.3%	0.8%	0.4%
Manufacturing of pulp, paper, printing & recorded media	1.9%	1.6%	1.3%	2.2%	1.2%	0.8%	3.0%	1.6%	2.3%	0.5%	1.6%
Manufacture of Coke, Oil & Nuclear	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.6%	0.6%	1.6%	0.0%	0.3%
Manufacturing of chemicals	4.8%	10.9%	4.6%	6.0%	13.1%	10.7%	4.5%	10.0%	4.4%	4.5%	6.6%
Manufacturing of rubber & plastic products	3.4%	5.2%	0.9%	2.0%	4.0%	1.2%	1.5%	3.2%	1.1%	2.3%	2.1%
Manufacturing of other mineral products	1.4%	1.6%	0.7%	0.7%	0.8%	4.6%	0.7%	2.9%	3.0%	3.0%	1.8%
Manufacturing of metals	11.3%	17.1%	2.6%	14.7%	14.8%	6.0%	6.3%	15.1%	5.1%	9.4%	8.6%
Manufacturing of machinery & equipment nec	2.3%	2.4%	0.7%	3.8%	6.1%	2.7%	2.3%	3.2%	1.3%	1.3%	2.2%
Manufacturing of electrical & optical equipment	3.9%	1.4%	2.4%	4.9%	1.5%	2.2%	3.7%	2.3%	2.3%	2.4%	2.7%
Manufacturing of transport equipment	3.6%	0.6%	3.4%	1.9%	1.1%	0.6%	7.2%	3.3%	2.3%	3.3%	3.0%
Manufacturing nec	3.0%	1.4%	0.6%	2.4%	1.1%	1.1%	1.1%	4.1%	1.1%	1.1%	1.5%
Electricity, gas & water	6.9%	3.0%	2.3%	15.0%	4.6%	11.7%	6.3%	5.1%	6.7%	9.3%	6.5%
Construction	7.5%	6.1%	2.6%	7.6%	6.2%	8.3%	14.1%	6.5%	7.7%	8.8%	7.1%
Distribution & hotels	4.4%	4.6%	5.1%	4.4%	3.5%	4.3%	4.5%	4.0%	5.7%	3.9%	4.6%
Transport & communication	12.8%	18.2%	32.0%	8.5%	19.3%	14.1%	14.4%	8.1%	15.2%	12.8%	17.8%
Financial & business services	5.4%	3.7%	13.6%	3.6%	3.5%	10.8%	7.9%	2.8%	10.7%	3.8%	7.8%
Public administration	3.6%	3.0%	6.8%	2.5%	3.1%	4.7%	3.2%	2.7%	3.0%	2.3%	3.9%
Education & health	5.5%	8.2%	9.3%	5.7%	4.3%	7.7%	5.7%	5.1%	4.3%	4.7%	6.4%
Other personal services	4.0%	5.3%	5.7%	3.3%	3.0%	3.2%	4.7%	4.0%	5.3%	4.0%	4.5%

Figure 12: Greenhouse gas footprint of Greater Manchester industry (% of total)

4 Using consumption metrics in policy

4.1 A template for action

The table below shows how the Total Footprint can be used as a policy tool – for understanding the impacts of current policy and trends, identifying gaps in policy, assessing the impact of putative policies and mapping future policy.

Within each segment of the footprint, there can be policies affecting the supply-side (such as infrastructure), the demand side (often behavioural) and sometimes both. And, in practice, policies (whether they are designed to be low carbon or not) usually impact on several segments, often in unintended ways.

This template[1] below breaks down each segment to the next level of detail, typically clusters of behaviours on the demand-side (such as driving to/from work) or, on the supply side, factors in the carbon efficiency of providing goods and services. The distinction is worth making; there is plenty of evidence that single interventions work less well than a mix of approaches.

The carbon management examples we have shared in Chapters 2 and 3 illustrate how action can be taken on both supply- and demand- side. The task for Greater Manchester's policy makers is to map current policy and its impact (including policies and trends where the carbon impact has not been considered), and consider future policy needs. This is not to say that GM should enact policies on every segment of the footprint, on both supply and demand sides; but we do suggest that any lack of balance in approach should be considered and deliberate. For example, decarbonising the grid may be in central government's gift; and aeroplane efficiency may be beyond local government influence. As policies to date have focused on the production-based footprint, this is not currently the case.

[1] Initially designed by Warren Hatter for West Sussex County Council

Segment	Supply or Demand	Cause	Current policies and their impact	Future policy and impact
Household fuel	Demand	Heating the home		
		Cooking		
	Supply	Gas		
		Oil for power		
Domestic vehicle fuel	Demand	Driving to/from work		
		Driving for other purposes		
	Supply	Diesel, petrol		
Household electricity	Demand	Heating		
		Appliances		
		Lighting		
	Supply	On-grid non-renewable supply		
Personal Flights	Demand	Air travel for leisure		
	Supply	Aeroplane fuel & airline/airport activity		
Travel by train, bus and other transport	Demand	Public transport to/from work		
		Public transport for other purposes		
	Supply	Supply and operation of buses, trains, etc		
Car manufacture and maintenance	Demand	Car purchase, maintenance and rental		
		Manufacture		
	Supply	Material		
Food and drink from retail	Demand	Food, drink consumed		
		Food and drink wasted		
	Supply	Food waste		
		Growing		
		Processing		
		Packaging		
		Distribution		
Eating, drinking, staying and staying away from home	Demand	Overnight stays		
		Eating out & takeaways		
		'Going out' / pub visits		
	Supply	Heating		
		Food / drink		
		Electricity		
		Travel		
Electrical goods	Demand	Replacing / upgrading equipment		
	Supply	Production		
		Distribution		
Other non-food shopping	Demand	Buying goods e.g. new clothes, books etc		
	Supply	Materials		
		Manufacture		
		Distribution		
Other bought services (including financial services	Demand	Purchase of financial & other services		
	Supply	Operational emissions		
Water, waste & sewage	Demand	Drinking, cooking		
		Flushing, laundry, etc (Health and Hygiene)		
		Hosepipes and swimming pools?		
	Supply	Sewage treatment		
		Transport / infrastructure		
Health care	Demand	Appointments, care processes / treatment		
	Supply	Transport / infrastructure		
Education	Demand	Teaching / schooling		
	Supply	Transport / infrastructure		
Public Admin. defence and other public services	Demand	Public service usage		
	Supply	Delivery emissions		
Domestic construction	Demand	New housing		
		Repairs, maintenance and improvements		
	Supply	Materials		
		Energy & equipment		
		Waste		

4.2 Clusters of Activity

By considering the total carbon footprint of consumption by residents as well as the footprint of industry, a wealth of opportunity opens up for bringing about multiple economic and social benefits for GM from taking supply- and demand- side measures to save carbon. It is important that carbon management actions are seen in this wider context so that the full potential for improving lives and businesses in the county can be realised through the management of the carbon budget.

For example, reductions in food waste can play a role in alleviating household poverty whilst cutting carbon and some dietary changes even have potential simultaneously to improve health, alleviate poverty, save carbon. Other actions stand to boost the local economy in different ways whilst cutting carbon.

To help with policy development we have worked up eight illustrative examples of *clusters* of activity with a projected carbon impact. They illustrate the way in which sets of actions can be built around themes, such that they support each other and deliver, between them, multiple benefits for GM around each theme. Our list should not be taken to be either complete or optimised, but rather as a start- point for thought, discussion and consultation.

Each cluster delivers a different cocktail of benefits alongside the carbon savings. These include:

- business efficiencies,
- improved local markets for businesses
- household savings and especially, poverty alleviation
- the development of new local industries and jobs for a resource constrained age
- health benefits

For each of the clusters below we have set the high level actions such that each cluster would deliver annual savings of around 1% of the total carbon footprint of residents. In this way the feasibility and attractiveness of delivering carbon savings through the different clusters can be compared. Our figures are just 'back of envelope' estimates based on many unstated assumptions.

In order to deliver, for example, savings equivalent to, 1% of the total consumption-based footprint per year for five years, it would be necessary to adopt, over that five year period, five of the clusters listed here at the level described or just one cluster at five times the level described, or some other combination of these or other clusters equivalent to five of the clusters of actions as listed here.

Cluster	Rationale	Actions	Saving (t'000 CO_2e)	% of resident footprint
Food Consumption: Cut waste, change diets diet, encourage seasonality and reduced packaging.	Food accounts for 20% + of the footprint. Around a quarter of edible food is thought to be thrown away. Alongside carbon savings there are big cost savings from cutting waste. For many, dietary improvements have potential to reduce carbon and improve health and save money. Possible opportunities also to support local seasonal producers	Reduce household food waste by 15%	298	0.7%
		Reduce meat and dairy by 3%	72	0.2%
		Increase uptake of local seasonal fruit and veg by 6%	48	0.1%
Low carbon Procurement: Resource efficiency and low carbon supply chains.	Much of this is simple business improvement for an efficient Greater Manchester economy, regardless of climate change. Scope for saving money is potentially much higher than the can be achieved from cutting energy bills. Local procurement is often lower carbon.	Through resource efficiency reduce purchasing per GVA by 1%	337	0.8%
		Improve supply chain carbon efficiency by 0.25%	84	0.2%
Local Leisure: Holiday and relax on your doorstep. Promote tourism and leisure industry locally to locals.	Potential opportunities for residents to save money and reduce stress *AND* have longer holidays, whilst boosting local tourism industry. Requires some shifts in thinking.	Reduce leisure flights by 5%, swapping for local leisure	230	5.5%
		Swap 100 car miles per capita per year for local alternatives	182	4.5%
Manchester Travel Improve public transport provision and information. Careful driving	Opportunities to make Greater Manchester a better place to live and work, saving staff and business time and money and creating lifestyle and business opportunities whist cutting carbon. Road safety benefits.	Careful driving initiative improves mpg by 3% throughout the county	164	0.4%
		Apps and websites make car alternatives more popular by 2%	108	0.25%
		Reduce car commuting by 20%	153	0.35%
Construction and planning for sustainable living. Construction locations and designs for sustainable living.	It takes time to make big changes but the effects are lasting with economic, lifestyle and sustainability benefits.	infrastructure and built environment planning to enable sustainable living reduces need for domestic car travel by 7.5%	410	1.0%
Household energy and water efficiency: Emphasising well targeted retrofits	Cost savings and opportunities for local business too. Lasting infrastructure improvements for the county. Probably already in hand to some extent. The water element doesn't link strongly to carbon savings.	Household energy efficiency improvement of 5.5%	424	1.0%
Industry energy and water efficiency	As above	Business energy and transport efficiency by 2.3%	407	1.0%
'Maintain, mend and pass it on': Support and promote second hand markets and, repair and maintenance industries	Cost savings for households and industries as well as a potential opportunity for Greater Manchester to lead in the development of a set of industries that will surely become more important under almost all scenarios for the UK and global economy over the coming decades.	Grow second hand , repair and refurbish industries to reduce consumer non food goods purchases by 1%	67	0.2%
		Grow second hand , repair and refurbish industries to reduce industry procurement of new goods by 1%	337	0.8%

5 Appendix A: Methodology

5.1 A consumption based approach

Whilst the term 'footprint' is used in various ways, we are using it to mean the sum of the direct emissions and the indirect emissions that arise throughout supply chains of activities and products. The inclusive treatment of supply chain emissions, as presented here, differs from more standard 'production-based' emissions assessments but gives a more complete and realistic view of impacts of final consumption.

As an example, emissions resulting from the purchase of goods by residents would not feature in an assessment of direct emissions (described as Scope 1 in the GHG Protocol (see below)), or those from electricity (Scope 2 in the GHG Protocol) since all the emissions take place in the supply chains of the products rather than at the point of purchase. To give another example, in a consumption based assessment, the footprint of travel includes, on top of the direct vehicle emissions, those resulting from the extraction, shipping, refining and distribution of fuel, emissions resulting from the manufacture and maintenance of vehicles, and so on. Thus, in the case of car travel the final figure is typically around double that of the exhaust pipe emissions. In a third example, the footprint of electricity consumption includes components for the emissions associated with fossil fuel extraction, shipping, refining and transport to power stations, as well as those resulting from the electricity generation process itself.

5.2 Inclusion of the Kyoto greenhouse gases

This assessment considers the basket of gases that is covered in the Kyoto Protocol, expressed in terms of carbon dioxide equivalent (CO_2e), the sum of the weights of each gas emitted multiplied by their global warming potential (GWP) relative to carbon dioxide over a 100 year period.

5.3 GHG Protocol guidelines

We have followed the reporting principles of the *'GHG Protocol'* (GGP) published by the World Business Council for Sustainable Development (WBCSD) and the World Resources Institute (WRI)[1].

The GGP provides a choice of three scopes for emissions reporting. Scope 1 covers direct emissions from company-owned vehicles and facilities. Scope 2 includes net emissions from energy imports and exports, such as electricity. Scope 3 includes other indirect emissions resulting from company activities, as detailed by the boundaries of the study. This report includes all Scope 1 and 2 emissions and comprehensive treatment of Scope 3 emissions throughout supply chains of activities and purchases within the boundaries laid out above.

5.4 Treatment of high-altitude emissions

High-altitude emissions from aircraft are known to have a higher global warming impact than would be caused by burning the equivalent fuel at ground level. Although the science of this is still poorly understood, this study has applied an emissions weighting factor of 1.9 to aircraft emissions, to take this into account. This is the figure suggested in Defra's *'Guidelines for Company Reporting on GHG Emissions[2]'*. The figure can also be inferred from the Intergovernmental Panel on Climate Change's (IPCC) Fourth Assessment Review[3].

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[1] Ranganathan, J. *et al* (2006)

[2] Defra, 2010[a]

[3] IPCC 2007

5.5 Boundaries

5.5.1 Residents footprint

The following is within the scope:

- fuel and electricity consumed in homes,
- all residents' personal travel both within and outside Greater Manchester, including commuting,
- emissions from food and drink and other purchased goods and services,
- the supply chains of all the above (e.g. fuel supply chains and embodied emissions),
- water supply, sewage and waste,
- healthcare,
- education,
- other public services whether delivered at a local or national level,
- construction, maintenance and improvement of dwellings.

The following is specifically excluded from the scope:

- business emissions including business travel (except in so far as the business output is consumed by residents).

5.5.2 Industry footprints

The following is within the scope:

- direct emissions,
- electricity,
- travel and transport,
- emissions from purchased goods and services,
- fixed capital formation,
- the supply chains of all the above (e.g. fuel supply chains and embodied emissions).

The following is specifically excluded from the scope:

- commuting,
- emissions from staff activity outside the workplace.

5.6 How the footprints were estimated

5.6.1 A hybrid of 'top down' and 'bottom up' approaches

The methodology draws upon and combines two basic approaches:

- Use of 'bottom up' data, where available, to estimate consumption, combined with emissions factors to estimate the associated emissions.
- Use of 'top down' macro-economic modelling; environmental Input–Output analysis (EIO).

Sufficiently high quality consumption data exists for household energy and flying to allow a primarily bottom up approach, with top down modelling used to ensure that emissions factors take account of full supply chains. For all other resident consumption categories, a first approximation was obtained by multiplying the population of each district by a general figure for the average UK resident derived from 'top down' EIO (see below). We then improved upon our first estimate through a series of adjustments wherever available data provided a reasonable basis for doing so based on local data (normalised per capita to the national average) and plausible assumptions. These data sets and assumptions are detailed in Appendix C below.

Industry emissions were estimated purely using EIO and turnover and GVA data from the Greater Manchester Forecast Model.

5.6.1 Environmental Input–Output analysis (EIO)

EIO combines economic information about the trade between industrial sectors with environmental information about the emissions arising directly from those sectors to produce estimates of the emissions per unit of output from each sector. The central technique is well established and documented[4]. In the UK, the main data sources are the *'Combined Supply and Use Matrix for 123 sectors'* and the *'UK environmental accounts'*[5], both provided by the Office of National Statistics (ONS).

The specific model used for this project was developed by Small World Consulting with Lancaster University is described in detail below and elsewhere[6]. This model takes account of such factors as the impact of high altitude emissions that are not factored into the environmental accounts and the effect of imports. In order to use more up to date (2008 rather than 1995) data, we have employed a simple algorithm for converting between basic and purchasers prices. We have used consumer industry specific consumer price indices to adjust for price changes since the date to which the supply and use tables relate.

Three main advantages of EIO over more traditional process-based life-cycle analysis (LCA) approaches to GHG footprinting are worth noting:

- EIO attributes all the emissions in the economy to final consumption. Although, as with process-based LCA, there may be inaccuracies in the ways in which it does this, it does not suffer from the systematic underestimation (truncation error) that process-based LCAs incur through their inability to trace every pathway in the supply chains[7].
- EIO has at its root a transparently impartial process for the calculation of emissions factors per unit of expenditure, whereas process-based LCA approaches entail subjective judgements over the setting of boundaries and the selection of secondary conversion factors.
- Through EIO, it is possible to make estimates of the footprints resulting from complex activities such as the purchase of intangible services that LCAs struggle to take into account.

One of the limitations of EIO in its most basic form is that it assumes that the demands placed upon (and therefore the direct emissions from) other sectors by a unit of output within one sector are homogeneous. As an example, a basic EIO model does not take account of the carbon efficiencies that may arise from switching the expenditure on paper from a virgin source to a renewable source without reducing the actual spend. In this report, the carbon intensity per unit turnover of, for example, the hotels, pubs and catering establishments of Greater Manchester are assumed to be 'UK typical'. It is possible, with additional resource, to make bespoke adjustments to these generalities given relevant local data and a defendable basis for relating that data to emissions. A further assumption in the model used here is that goods from overseas are produced with the same carbon efficiency as they would have been in the UK. Overall, this assumption usually results in an underestimation of the footprint of purchased goods. A further omission for this and all EIO models that we are aware of is that the impact of land-use change around the world has not been taken

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[4] for example Leontief, 1986; Miller & Blair, 2009

[5] ONS, 2010[a]; ONS, 2010[b]

[6] Berners-Lee et all2011 (Science of the Total Environment, 409. Greenhouse gas footprinting for small businesses — The use of input–output data.

[7] Lenzen, 2001; Nässén *et al,* 2007

into account. This would be likely to result in an increased assessment of the footprint of foods, especially animal products[8].

5.6.2 EIO methodology detail

The specific methodology and sources underpinning our model are outlined below in steps, along with some brief discussion.

Throughout the following, matrices and vectors are written in capitalized bold font, while the individual elements of a matrix are denoted by the small cap of the name of the matrix and are not bolded. The operations in equations involving matrix or vector elements are standard mathematical operations while those in equations involving matrices are the corresponding matrix operations.

Step 1: A technical coefficients matrix of inputs from each sector per unit output of each sector (**A**) has been derived from an update to the UK Input–Output Analyses 2010 edition, table 3 'Demand for products in 2008 Combined Use Matrix', based on 2008 data and obtained from the ONS[9]. (The ONS publishes on only 93 sectors for 2007 but released to us a 123 sector breakdown of 'unbalanced' figures. We used these, judging that the benefit of disaggregation outweighs to risks from not going through the balancing process. Encouragingly, the disaggregated data set was in line with estimates based on extrapolation from the 2008 data set.) This matrix deals with the UK economy broken down into 123 industry groups. The process assumes that the output stimulated in each sector per unit demand at purchaser's prices is homogeneous and independent of the purchaser.

The matrix is usually derived from use tables of inputs at basic prices, which are output prices before distributers' margins, taxes or subsidies have been applied. However, for the UK these have not been published since 1995. By using purchasers' prices rather than basic prices to determine the technical input coefficients more recent data from 2008 data can be used rather than 1995 data. The trade-off is that it entails the assumption that demand at purchasers prices (including taxes, subsidies and distributors margins) is as good a guide to industry activity as demand at basic prices. Both of these values are surrogates for the stimulation of emissions-causing activity.

Step 2: Gross fixed capital formation is reallocated from final demand to intermediate demand, since the ongoing formation of capital is required to support the supply of goods and services and is therefore instrumental in enabling the production of goods and services.

Step 3: The Leontief inverse (**L**) of the technical coefficients matrix consists of a matrix of sectoral output coefficients as stimulated per unit final demand, all at basic prices.

$$\mathbf{L} = (\mathbf{I}-\mathbf{A})^{-1} \qquad \text{Equation 1}$$

Where **I** is the identity matrix.

Step 4: The UK Environmental Accounts[10] give the GHG emissions in 2008 arising directly from 93 SIC (Standard Industrial Code) sectors. These are mapped onto the 123 ONS IO Table industry groups by a

[8] Audsley *et al.* 2010; This report estimates that emissions from red meat production outside Europe rises by a factor around five when land-use change is taken into account.
[9] ONS, 2010[a]
[10] ONS, 2010[b]

process of splitting out SIC code emissions into IO industry groups in proportion to total output at basic prices and where necessary combining SIC codes into single Input–Output industry groups.

Step 5: Emissions from aviation at altitude are known to have a higher impact than the same emission at ground level[11]. An emissions weighting factor of 1.9 was applied to the CO_2 emissions associated with the air transport sector to reflect additional radiative forcing per unit of GHG emitted. This simple mark-up factor is the figure proposed by Defra[12], based on the IPCC's discussion of aviation in its Fourth Assessment Report[13]. The application of this multiplier provides a first approximation to the impact of a complex and as yet poorly understood set of scientific phenomena surrounding aviation emissions.

Step 6: UK output by sector at basic prices[14] was combined with UK GHG emissions arising directly from each sector to derive a vector of coefficients of emissions per unit (£) of UK output from each sector at basic prices ($\mathbf{G_{UK}}$). This is the vector of GHG intensity of each sector per unit financial output.

For each industry,

$$g_{UK_i} = e_{D_i} / o_{BP_i} \quad i = 1 \text{ to } 123 \text{ (industrial sectors)} \qquad \text{Equation 2}$$

where $\mathbf{O_{BP}}$ is the vector of UK sector-specific output at basic prices and $\mathbf{E_D}$ is the vector of sector specific direct emissions.

Step 7: The matrix (**E**) of GHG emissions arising from each industry (i) per unit of final demand for each industry (j) at 2008 basic prices is calculated as:

$$e_{ij} = l_{ij} \cdot g_i \quad i = 1 \text{ to } 123 \text{ (industries)}, j = 1 \text{ to } 123 \text{ (industries)} \qquad \text{Equation 3}$$

Emissions intensity matrices based on different levels of import from within and beyond the EU can be constructed. In particular, we can substitute for g_i in the above equation to explore emissions intensities that might result where supply chains are typical of UK supply ($\mathbf{G_{UK\ Mix}}$), are based solely in the UK ($\mathbf{G_{UK}}$), solely in the EU ($\mathbf{G_{EU}}$), or solely outside the EU ($\mathbf{G_{Non\ EU}}$).

Step 8: Total emissions from each industry (i) arising from UK final demand for each industry (j) is given by

$$e_{Total_{ij}} = e_{ij} \cdot f_{BP_j} \qquad \text{Equation 4}$$

Where $\mathbf{E_{Total}}$ is the matrix of total emissions from each sector arising from final demand for each sector, and $\mathbf{F_{BP}}$ is the vector of final demand at 2008 UK basic prices.

Note that $\mathbf{F_{BP}}$ includes exports. To understand the impact of UK final demand, emissions from exports can be subtracted from each sector on a proportional basis.

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11 Rogers et al., 2002

12 Defra 2010[a]

13 IPCC, 2007

14 ONS, 2010[a]

Step 9: To obtain $\mathbf{F_{BP}}$, the final demand at purchasers' prices is adjusted by subtracting distributors margins taxes and subsidies, based on the assumption that these are split between domestic outputs at basic prices and imported products in the ratio of their respective monetary values

For industry i,

$$f_{BP_i} = f_{PP_i} - (d_i + t_i - s_i).(o_{BP_i} / (o_{BP_i} + b_i)) \qquad \text{Equation 5}$$

Where:

$\mathbf{F_{BP}}$ = Final demand at Basic Prices,

$\mathbf{F_{PP}}$ = Final Demand at Purchasers prices and

D,T,S, $\mathbf{O_{BP}}$ and **B** are the vectors of distributors' margins, taxes, subsidies, total output at basic prices and imports respectively.

A key assumption here is that distributor's margins, tax and subsidies are applied to domestic production and imports at the same rates and can therefore be apportioned to according to monetary value.

The data are obtained from Tables 2 and 3 in the UK Input–Output Analysis Tables[15].

Step 10: This step converts emissions factors from basic prices to purchasers' prices**.** The majority of this conversion is done simply by dividing by the ratio of final demands at purchasers and basic prices. However, there remains the question of allocating emissions arising from distribution services to the sectors whose products use those sectors.

In the UK IO tables, three distributor sectors require special treatment, since the products they deal with are not counted as inputs and only the marginal increase in their value is counted as outputs for those sectors. These sectors are 'Motor vehicle distributors', 'Wholesalers' and 'Retail'. The emissions associated with these three sectors have been aggregated and redistributed between the industries they serve in proportion to the distributor's margins that are associated with their products.

The core assumption here is that emissions arising from distribution services are in proportion to the margins they generate for the products of each other industry.

5.7 Derivation of emissions factors.

Where consumption estimates were based upon expenditure, the carbon intensity of activities and purchases have been taken from the EIO model.

Where emissions estimates have been based upon physical consumption, the direct components associated with fuel combustion, from electricity generation and from most transport have been calculated using conversion factors provided by Defra in their *'Guidelines for Reporting on GHG* Emissions'[16]. However, the

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[15] ONS, 2010[a]

[16] Defra, 2010[a]; more recently DECC has published supply chain emissions factors for energy use. We have not used these since they include only certain parts of the supply chains.

Defra emissions factors do not take full account of supply chain emissions, and these need to be considered separately and we used the EIO model for this.

5.8 Estimating consumption

5.8.1 Household energy

Consumption of household fuel and electricity in each district was taken from DECC's sub-regional energy data sets[17].

5.8.2 Personal air travel

Rather than beginning from a top down, Input–Output based UK average and adjusting, we adopted a bottom up approach based on Civil Aviation Authority Passenger Survey data[18] on flights by Greater Manchester residents from all major UK airports.

We analysed 5025 survey records of journeys made by Greater Manchester residents, weighted to represent all flights by residents from UK airports and broken down by district of residence and purpose (business or leisure). Only leisure flights were attributed to the residents' consumption. Great circle distances were fitted to each reported leg of each journey[19]. Journeys were categorised as Domestic (<800km), Short Haul (<3700 km) and Long Haul. Emissions factors supplied by Defra[20] were used to calculate emissions per flight, with, as recommended by Defra, a 9% addition to take account of actual flight distances over the great circle distance and, in line with the methodology throughout and as suggested by Defra, a mark-up factor of 1.9 was applied to take account of the effect of high altitude on the climate change impact of emissions. A further small component was added to the emissions factor to take account of indirect emissions from aviation and this was calculated from the EIO that is used extensively in this report.

It has not been possible to compare flights by Greater Manchester residents with the national average since this would have required purchasing of the national data set of all surveyed flights by UK residents. The results are 41% per capita higher than the UK average that would have been obtained through IO analysis. The alignment between the top down and bottom up approaches is encouragingly strong and it is possible to speculate, albeit with caution, on the reasons for the difference

20% of the emissions reported here resulted from flight legs that neither started nor finished in the UK and these are poorly (and almost certainly under) accounted for in the Input–Output analysis.

Finally, it is worth noting that journeys that neither start nor end in the UK are omitted from this analysis, leading to a small underestimation.

5.8.3 Household goods and services

Household income deciles[21] for each district were used to model the proportion of residents within each UK income decile. Expenditure on household foods, goods and services by each UK income decile as a

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17 DECC,2009[a,b&c]

18 CAA, 2011

19 Latitudes and longitudes were taken from Our Airports (2011)

20 Defra, 2010[a]

21 ONS[c], 2010

proportion of the UK average was derived from UK household expenditure survey and Defra's *'Family Food Survey'*[22]. In this way expenditure per capita as a ratio of the UK average was derived for each district.

5.8.4 Food

The family food survey[23] profiles consumption of food types against income deciles and we mapped this against the carbon footprint of food types based on Small World Consulting's model of the carbon in food categories at Booths Supermarkets[24].

5.8.5 Vehicles and vehicle fuel

Vehicle fuel consumption per capita was assumed to be proportional to vehicle ownership (taken from Dept. for Transport vehicle licensing statistics[25]).

Expenditure on vehicles themselves (and therefore embodied emissions resulting from vehicles) was taken to be proportional to fuel consumption within each income decile.

5.8.6 Waste

Per capita waste was derived from Defra Annual Municipal Waste Statistics[26].

5.9 Uncertainties

The complexity of supply chains and the difficulties in obtaining accurate data dictate that footprinting can only offer a best estimate rather than an exact measure, and the figures in this report should be viewed in that context. We have operated from the principle that it is more informative to make best estimates of even the most poorly understood components of the footprint, and to discuss the uncertainty openly, than to omit them from the analysis.

Overall, the results in this report should be viewed as offering a broad guide to the size and relative significance of different components.

5.9.1 Uncertainties over data

We have relied on national surveys of household expenditure[27] and CAA[28] passenger surveys. Sample sizes for both these are high and statistical techniques have been used to represent populations. However, the surveys rely on self reporting and this can bring about significant error.

Sub-regional energy consumption estimates from DECC[29] and vehicle ownership statistics from the DfT[30] are probably high enough quality not to contribute significantly to the overall uncertainty.

5.9.2 Uncertainties over conversion factors

The areas in which the relationship between consumption and footprints is best understood are gas and electricity consumption. There is relatively good consensus over conversion factors to within around 5% in

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22 ONS[d], 2010; Defra, 2010[b]
23 Defra, 2010[b]
24 Booths, 2010
25 DfT, 2011
26 Defra Annual Municipal Waste Stats (2009/10)
27 Defra, 2010[b]; ONS[c], 2010
28 CAA, 2011
29 DECC, 2009[a,b&c]
30 DfT, 2011

these areas. The next most certain group of conversion factors are those for travel and transport. In this category, there is uncertainty over the impact of high altitude emissions and the embodied emissions in the manufacture and maintenance of vehicles, roads and other infrastructure.

Supplies and services are the areas of greatest uncertainty. As an example, credible process based life cycle analyses of a particular specification of paper typically differ by factors of around 50% depending on the specific practices employed in the particular mill in which it was manufactured. It would also be possible for two detailed studies of exactly the same process to arrive at significantly different estimates, depending on the precise assumptions made. The EIO approach that we have adopted overcomes the truncation error that process-based approaches incur, but does suffers its own series of problems, most notably errors of generalisation – the failure to look at the particular circumstances of a supply chain rather than an industry average.

5.9.3 Modelling local differences

The use of local data to make adjustments from UK averages has involved a series of judgements in consultation with academics and others, based on the best available local data and assumptions about the linkages between this and consumption. In some areas, the local data was high quality and the basis for making adjustment was clear cut. This was the case for domestic energy use and personal flights. In other areas the uncertainty was considerably higher. Areas for which better data would be particularly valuable for the future are as follows.

- Residents travel by car and public transport. Whilst data exists for all travel within districts, we lacked solid data on the total travel by residents using different modes (most of which occurs outside their own district or Greater Manchester).
- Consumption of other goods and services relied heavily on socio-economic data, assuming UK average linkage between wealth and consumption. It would be valuable to have Greater Manchester and / or district specific data on diets, food waste and consumption of goods and other services.
- For the industry footprint, any data from which the scope 1, 2 or 3 carbon intensity of industry categories in the Forecast Model compared to the UK average for that industry could be inferred would be valuable. In the future, scope 1 and 2 emissions from these industry categories could usefully be fed into a modified version of the model.

5.9.4 Other uncertainties

The modelling itself has required many complex calculations. Despite careful checking of formulae and sense checking of results, the possibility of human error can never be wholly eliminated.

5.10 Repeating the process in GM and elsewhere

This work has been carried out in such a way as to make the process both repeatable elsewhere and improvable, building upon this work. To this end, the methodology has been described in fine detail. Data sources and detailed assumptions have also been listed. The model into which data and detailed assumptions have been input has also been made available to Manchester City Council.

6 Appendix B: Notes on the usefulness of reporting at a district level

Part of the purpose of reporting total carbon footprint at a district level was to evaluate to usefulness of the exercise for the future in Manchester and elsewhere. Three questions are important;

- Is the district level data of high enough quality to allow a meaningful analysis?
- Does the analysis yield results that enable better carbon management decision making?
- Are there other forms of analysis that would be more fruitful from a carbon management perspective?

6.1 Is the quality of data adequate?

Household fuel and data on personal flights does seem robust enough to allow meaningful comparison between districts.

Vehicle ownership data is also high quality and in so far as this is a guide to vehicle fuel consumption, this too can be meaningfully compared at a district level.

For other household purchases, we have relied on socio-economic data (and household income data in particular) and national expenditure, food and nutrition surveys to differentiate between districts. While self-reporting surveys can be problematic, the quality of these sources is probably adequate to model expected differences in consumption that may arise from differences in income. However, no other local factors are reflected in our analysis (except in the case of cars purchases and maintenance, where we have used this type of analysis in conjunction with vehicle ownership analysis).

We were unable to find sources of data that would allow us to model differences in use of public services and this is therefore the same per capita between districts.

6.2 Do the district level results enable higher quality carbon management decisions?

Most of the time the differences between districts are fairly small. There is a 28% difference between the highest and lowest per capita total carbon footprints.

There are greater differences within some consumption categories. For example the people of Stockport have more than double the flying footprint of the people of Tameside. Meanwhile the people of Manchester have less than three quarters of the household fuel footprint per person compared to Stockport residents, even though electricity consumption is almost as high. These differences could be high enough to call for significant differences in emphasis for districts seeking well-targeted ways to influence consumption.

In the case of food, the differences turn out to be slight. The carbon intensity of food increases somewhat with income, but not proportionally. Every district contains in mix of well of and less well off households. These two factors mean that district level analysis food footprints is not particularly interesting.

No differences in use of public services are modelled between districts and it is important not to create a misleading impression that the per capita footprints are known to be the same for each in these categories.

6.3 Are there more fruitful ways to disaggregate the footprints?

In the cases of household energy and personal flights, the consumption data allows spatial disaggregation more easily than any other. The differences between districts are significant and it may well be possible to manage them at this level.

For other areas of consumption, examining the differences between socio economic profiles may me more fruitful in the future, since this may show up differences in the key messages that different socio-economic groups can most usefully be give. For example, poorer households spend disproportionately more of their income on food and food is also a higher proportion of their total footprint. This group may be most receptive to messages that encourage both carbon and cost savings. This group may well fly so little that awareness raising about the impact of aviation may be poorly targeted effort. On the other hand, there may be socio economic groups for whom leisure flights are the most important carbon issue.

6.4 Summary

Overall, the district level analysis is most useful for flights and household energy use. It is also useful for looking at resident car travel, particularly if better quality data can be obtained.

It would be worthwhile to look at socio-economic breakdowns, as these are likely to show up strong differences and inform very significantly differentiated messaging for different groups.

7 Appendix C: Residents' data and adjustment factors

Attribute	Year	Unit	Bolton	Bury	Manc.	Oldham	Roch.	Salford	Stockport	Tameside	Trafford	Wigan	GM	UK	Source
Total population	2010	PPL	266,185	183,524	492,963	219,349	205,238	226,591	284,588	216,403	217,308	307,715	2,619,864	62,150,600	GMFM
Average gross earnings	2010	£ / week	423	468	415	430	447	422	504	401	613	428	455	488	ONS 2010[c]
Total municipal waste	2009 /10	tonnes	111,092	79,912	208,522	95,815	69,863	107,602	107,803	91,486	93,038	160,972	1,126,105	33,362,517	Defra 2009/10
Gas (domestic)	2009	GWh	1,776	1,276	2,496	1,418	1,339	1,356	2,020	1,411	1,590	1,953	16,635	347,170	DECC 2009[a]
Electricity (domestic)	2009	GWh	475	327	836	350	348	435	521	371	407	530	4,601	143,986	DECC 2009[b]
Petroleum (domestic)	2009	GWh	11.7	6.7	11.0	8.3	9.1	7.1	9.8	8.0	7.0	14.6	93.4	35,489.3	DECC 2009[c]
Coal (domestic)	2009	GWh	2.5	1.0	0.4	1.5	1.7	1.0	0.6	2.0	0.4	4.2	15.4	4,376.5	DECC 2009[c]
Manufactured solid fuels (dom.)	2009	GWh	1.1	0.4	0.2	0.7	0.7	0.4	0.3	0.9	0.2	24.1	28.8	4,585.5	DECC 2009[c]
Domestic fuel total (excl. elec.)	2009	GWh	1,791	1,284	2,508	1,428	1,350	1,364	2,031	1,422	1,597	1,996	16,772	391,621	DECC 2009[c]
Number of cars per capita	2010	N° cars	0.43	0.50	0.27	0.39	0.40	0.36	0.57	0.41	0.62	0.45	0.44	0.47	DfT 2010
Carbon from food	2009/10	000 tCO_2e/a.	32.4	25.9	64.1	29.0	28.0	29.4	35.3	28.7	24.4	27.7	26.5	32.4	Calculated from Defra 2010[b]
Household vehicle fuel	2009/10	£th/ annum	10,498	9,613	20,577	9,747	9,895	9,719	12,967	9,362	8,248	9,194	8,717	10,498	ONS 2010[d]
Train, bus and other transport	2009/10	£th/ annum	4,963	4,529	9,495	4,332	4,438	4,446	6,637	4,171	3,739	4,158	3,925	4,963	ONS 2010[d]
Cars	2009/10	£th/ annum	15,009	13,910	29,045	13,494	13,627	13,453	19,928	13,181	11,713	13,023	12,231	15,009	ONS 2010[d]
Food and drink from retail	2009/10	£th/ annum	1,846	1,495	3,594	1,661	1,659	1,684	2,130	1,603	1,375	1,560	1,494	1,846	ONS 2010[d]
Eating drinking & staying away	2009/10	£th/ annum	30,393	26,660	56,748	26,610	27,212	26,751	39,696	25,667	22,700	25,215	23,920	30,393	ONS 2010[d]
Electrical goods	2009/10	£th/ annum	6,541	5,784	12,758	5,907	5,938	5,959	7,796	5,727	5,012	5,616	5,328	6,541	ONS 2010[d]
Other non food shopping	2009/10	£th/ annum	27,965	22,675	53,484	24,652	24,223	24,908	32,743	24,104	20,694	23,367	22,361	27,965	ONS 2010[d]
Other bought services	2009/10	£th/ annum	77,488	66,109	150,619	70,228	70,307	70,908	91,222	67,832	58,871	66,243	63,145	77,488	ONS 2010[d]
Water and sewerage	2009/10	£th/ annum	5,016	3,545	9,794	4,315	3,989	4,459	4,877	4,348	3,596	4,144	4,000	5,016	ONS 2010[d]
Healthcare	2009/10	£th/ annum	2,805	2,222	5,392	2,501	2,490	2,481	3,248	2,406	2,047	2,336	2,235	2,805	ONS 2010[d]
Education	2009/10	£th/ annum	2,259	1,720	3,231	1,504	1,668	1,570	3,926	1,387	1,297	1,435	1,329	2,259	ONS 2010[d]
Construction	2009/10	£th/ annum	3,746	3,226	7,198	3,410	3,470	3,437	4,465	3,234	2,824	3,171	3,028	3,746	ONS 2010[d]
Carbon from flights	2009/10	tonnesCO_2e/a	465,109	258,286	1,082,870	342,864	243,864	410,498	680,946	237,817	409,180	472,366	4,603,801	465,109	CAA 2011; Defra 2010[a] Our Airports 2010
Distance flown	2009/10	000 km	1,107,058	613,769	2,542,257	814,658	577,148	965,730	1,628,517	567,744	976,934	1,130,439	10,924,254	1,107,058	CAA 2011; Defra 2010[a] Our Airports 2010
Number of flights	2009	000's	376	221	963	270	194	303	601	202	390	365	3,886	376	CAA 2011; Defra 2010[a] Our Airports 2010

Category	tCO_2e/capita	Basis for adjustments		Adjustment Factors										
		Description of basis	Source	Bolton	Bury	Man.	Oldham	R'dale	S'ford	S'port	T'side	Trafford	Wigan	GM
Household fuel (direct	1.37	Per capita annual household fuel consumption (exc. electricity) as a proportion of UK average.	DECC 2009[c]	1.07	1.11	0.81	1.03	1.04	0.96	1.13	1.04	1.17	1.03	1.02
Coal extraction	0.02	Per capita annual household coal consumption as a proportion of UK average.	DECC 2009[c]	0.13	0.08	0.01	0.10	0.12	0.06	0.03	0.13	0.02	0.19	0.08
Oil and gas extraction	0.00	Per capita annual household gas consumption as a proportion of UK average.	DECC 2009[a]	1.19	1.24	0.91	1.16	1.17	1.07	1.27	1.17	1.31	1.14	1.14
Gas distribution	0.45	Per capita annual household gas consumption as a proportion of UK average.	DECC 2009[a]	1.19	1.24	0.91	1.16	1.17	1.07	1.27	1.17	1.31	1.14	1.14
Household Vehicle fuel (direct	1.04	UK average car ownership multiplied by relative car ownership in district.	DfT 2010	0.93	1.07	0.58	0.83	0.86	0.78	1.23	0.89	1.32	0.97	0.95
Coke ovens, refined	0.41	UK average car ownership multiplied by relative car ownership in district.	DfT 2010	0.93	1.07	0.58	0.83	0.86	0.78	1.23	0.89	1.32	0.97	0.95
Electricity production and	1.37	Per capita annual electricity consumption as proportion of UK average.	DECC 2009[b]	0.77	0.77	0.73	0.69	0.73	0.83	0.79	0.74	0.81	0.74	0.76
Air Transport	1.25	Replaced with calculations based on 2009 CAA Passenger Survey, Great circle distances for all flights, and Defra's	CAA 2010; Defra	1.40	1.13	1.76	1.25	0.95	1.45	1.92	0.88	1.51	1.23	1.41
Railway transport	0.08	Per capita annual spend on trains and other transport (weighted by decile) as a proportion of UK ave.	ONS 2010[d]	0.92	0.94	0.84	0.84	0.87	0.85	1.05	0.83	1.09	0.88	0.93
Other land transport	0.20	Per capita annual spend on trains and other transport (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.92	0.94	0.84	0.84	0.87	0.85	1.05	0.83	1.09	0.88	0.93
Water transport	0.14	Per capita annual spend on trains and other transport (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.92	0.94	0.84	0.84	0.87	0.85	1.05	0.83	1.09	0.88	0.93
Ancillary Transport services	0.02	Per capita annual spend on trains and other transport (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.92	0.94	0.84	0.84	0.87	0.85	1.05	0.83	1.09	0.88	0.93
Motor vehicles	0.89	Per capita annual spend on cars (weighted by decile) as a proportion of UK average and the average UK average	ONS 2010[d]; DfT	0.86	1.02	0.50	0.72	0.77	0.67	1.29	0.76	1.44	0.88	0.89
Motor vehicle distribution and	-	Per capita annual spend on cars (weighted by decile) as a proportion of UK average and the average UK average	ONS 2010[d]; DfT	0.86	1.02	0.50	0.72	0.77	0.67	1.29	0.76	1.44	0.88	0.89
Agriculture	0.76	Per capita annual spend on food (weighted by decile and carbon footprint of diet) as a proportion of UK average.	Defra 2010[b]	0.99	0.99	0.97	0.98	0.98	0.97	1.01	0.97	1.01	0.98	0.99
Fishing	0.01	Per capita annual spend on food (weighted by decile and carbon footprint of diet) as a proportion of UK average.	Defra 2010[b]	0.99	0.99	0.97	0.98	0.98	0.97	1.01	0.97	1.01	0.98	0.99
Meat processing	0.30	Per capita annual spend on food (weighted by decile and carbon footprint of diet) as a proportion of UK average.	Defra 2010[b]	0.99	0.99	0.97	0.98	0.98	0.97	1.01	0.97	1.01	0.98	0.99
Fish and fruit processing	0.17	Per capita annual spend on food (weighted by decile and carbon footprint of diet) as a proportion of UK average.	Defra 2010[b]	0.99	0.99	0.97	0.98	0.98	0.97	1.01	0.97	1.01	0.98	0.99
Oils and fats	0.01	Per capita annual spend on food (weighted by decile and carbon footprint of diet) as a proportion of UK average.	Defra 2010[b]	0.99	0.99	0.97	0.98	0.98	0.97	1.01	0.97	1.01	0.98	0.99
Dairy products	0.28	Per capita annual spend on food (weighted by decile and carbon footprint of diet) as a proportion of UK average.	Defra 2010[b]	0.99	0.99	0.97	0.98	0.98	0.97	1.01	0.97	1.01	0.98	0.99
Grain milling and starch	0.05	Per capita annual spend on food (weighted by decile and carbon footprint of diet) as a proportion of UK average.	Defra 2010[b]	0.99	0.99	0.97	0.98	0.98	0.97	1.01	0.97	1.01	0.98	0.99
Animal feed	0.05	Per capita annual spend on food (weighted by decile and carbon footprint of diet) as a proportion of UK average.	Defra 2010[b]	0.99	0.99	0.97	0.98	0.98	0.97	1.01	0.97	1.01	0.98	0.99
Bread, biscuits, etc	0.10	Per capita annual spend on food (weighted by decile and carbon footprint of diet) as a proportion of UK average.	Defra 2010[b]	0.99	0.99	0.97	0.98	0.98	0.97	1.01	0.97	1.01	0.98	0.99
Sugar	0.01	Per capita annual spend on food (weighted by decile and carbon footprint of diet) as a proportion of UK average.	Defra 2010[b]	0.99	0.99	0.97	0.98	0.98	0.97	1.01	0.97	1.01	0.98	0.99
Confectionery	0.05	Per capita annual spend on food (weighted by decile and carbon footprint of diet) as a proportion of UK average.	Defra 2010[b]	0.99	0.99	0.97	0.98	0.98	0.97	1.01	0.97	1.01	0.98	0.99
Other food products	0.09	Per capita annual spend on food (weighted by decile and carbon footprint of diet) as a proportion of UK average.	Defra 2010[b]	0.99	0.99	0.97	0.98	0.98	0.97	1.01	0.97	1.01	0.98	0.99
Alcoholic beverages	0.09	Per capita annual spend on food (weighted by decile and carbon footprint of diet) as a proportion of UK average.	Defra 2010[b]	0.99	0.99	0.97	0.98	0.98	0.97	1.01	0.97	1.01	0.98	0.99
Soft drinks and mineral	0.06	Per capita annual spend on food (weighted by decile and carbon footprint of diet) as a proportion of UK average.	Defra 2010[b]	0.99	0.99	0.97	0.98	0.98	0.97	1.01	0.97	1.01	0.98	0.99
Hotels, catering, pubs etc	0.83	Per capita annual spend on eating, drinking and staying away from home (weighted by decile) as a proportion of	ONS 2010[d]	0.93	0.93	0.83	0.85	0.88	0.85	1.04	0.83	1.09	0.88	0.93
Recreational services	0.30	Per capita annual spend on eating, drinking and staying away from home (weighted by decile) as a proportion of	ONS 2010[d]	0.93	0.93	0.83	0.85	0.88	0.85	1.04	0.83	1.09	0.88	0.93
Domestic appliances nec	0.09	Per capita annual spend on electrical goods (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.95	0.99	0.91	0.93	0.95	0.92	1.02	0.91	1.05	0.95	0.97
Office machinery & computers	0.03	Per capita annual spend on electrical goods (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.95	0.99	0.91	0.93	0.95	0.92	1.02	0.91	1.05	0.95	0.97
Electric motors and	0.02	Per capita annual spend on electrical goods (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.95	0.99	0.91	0.93	0.95	0.92	1.02	0.91	1.05	0.95	0.97
Insulated wire and cable	0.02	Per capita annual spend on electrical goods (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.95	0.99	0.91	0.93	0.95	0.92	1.02	0.91	1.05	0.95	0.97
Electrical equipment nec	0.02	Per capita annual spend on electrical goods (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.95	0.99	0.91	0.93	0.95	0.92	1.02	0.91	1.05	0.95	0.97
Electronic components	0.00	Per capita annual spend on electrical goods (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.95	0.99	0.91	0.93	0.95	0.92	1.02	0.91	1.05	0.95	0.97
Transmitters for TV, radio and	0.01	Per capita annual spend on electrical goods (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.95	0.99	0.91	0.93	0.95	0.92	1.02	0.91	1.05	0.95	0.97
Receivers for TV and radio	0.08	Per capita annual spend on electrical goods (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.95	0.99	0.91	0.93	0.95	0.92	1.02	0.91	1.05	0.95	0.97
Medical and precision instruments	0.04	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Forestry	0.00	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Metal ores extraction	0.00	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Other mining and quarrying	0.00	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Tobacco products	0.04	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Textile fibres	0.00	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Textile weaving	0.00	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Textile finishing	0.00	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Made-up textiles	0.03	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Carpets and rugs	0.02	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96

Other textiles	0.01	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Knitted goods	0.05	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Wearing apparel and fur products	0.16	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Leather goods	0.01	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Footwear	0.02	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Wood and wood products	0.02	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Pulp, paper and paperboard	0.00	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Paper and paper products	0.06	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Printing and publishing	0.09	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Industrial gases and dyes	0.00	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Inorganic chemicals	0.00	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Organic chemicals	0.00	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Fertilisers	0.02	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Plastics & Synthetic resins	0.00	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Pesticides	0.00	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Paints, varnishes, printing ink etc	0.02	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Pharmaceuticals	0.03	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Soap and toilet preparations	0.08	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Other Chemical products	0.05	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Man-made fibres	0.00	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Rubber products	0.04	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Plastic products	0.04	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Glass and glass products	0.02	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Ceramic goods	0.02	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Iron and steel	0.00	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Non-ferrous metals	0.01	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Metal castings	0.00	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Metal boilers and radiators	0.00	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Metal forging, pressing, etc	0.00	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Cutlery, tools etc	0.03	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Other metal products	0.08	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Mechanical power equipment	0.02	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
General purpose machinery	0.02	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Agricultural machinery	0.00	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Machine tools	0.00	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Special purpose machinery	0.00	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Weapons and ammunition	0.00	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Shipbuilding and repair	0.03	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Other transport equipment	0.04	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Aircraft and spacecraft	0.01	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Furniture	0.12	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Jewellery and related	0.08	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Sports goods and toys	0.06	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Miscellaneous manufacturing	0.08	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Wholesale distribution	-	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Retail distribution	-	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Postal and courier services	0.01	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Renting of machinery etc	0.10	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Advertising	0.00	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96
Membership organisations	0.03	Per capita annual spend on other non-food shopping (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.96	0.91	0.92	0.94	0.92	1.02	0.91	1.04	0.93	0.96

Banking and finance	0.14	Per capita annual spend on other bought services (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.98	0.92	0.94	0.96	0.93	1.02	0.92	1.04	0.95	0.97
Insurance and pension funds	0.16	Per capita annual spend on other bought services (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.98	0.92	0.94	0.96	0.93	1.02	0.92	1.04	0.95	0.97
Auxiliary financial services	0.01	Per capita annual spend on other bought services (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.98	0.92	0.94	0.96	0.93	1.02	0.92	1.04	0.95	0.97
Owning and dealing in real	0.00	Per capita annual spend on other bought services (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.98	0.92	0.94	0.96	0.93	1.02	0.92	1.04	0.95	0.97
Letting of dwellings	0.30	Per capita annual spend on other bought services (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.98	0.92	0.94	0.96	0.93	1.02	0.92	1.04	0.95	0.97
Estate agent activities	0.00	Per capita annual spend on other bought services (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.98	0.92	0.94	0.96	0.93	1.02	0.92	1.04	0.95	0.97
Computer services	0.00	Per capita annual spend on other bought services (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.98	0.92	0.94	0.96	0.93	1.02	0.92	1.04	0.95	0.97
Research and development	0.00	Per capita annual spend on other bought services (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.98	0.92	0.94	0.96	0.93	1.02	0.92	1.04	0.95	0.97
Legal activities	0.00	Per capita annual spend on other bought services (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.98	0.92	0.94	0.96	0.93	1.02	0.92	1.04	0.95	0.97
Accountancy services	0.00	Per capita annual spend on other bought services (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.98	0.92	0.94	0.96	0.93	1.02	0.92	1.04	0.95	0.97
Market research,	-	Per capita annual spend on other bought services (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.98	0.92	0.94	0.96	0.93	1.02	0.92	1.04	0.95	0.97
Other business services	0.01	Per capita annual spend on other bought services (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.98	0.92	0.94	0.96	0.93	1.02	0.92	1.04	0.95	0.97
Other service activities	0.05	Per capita annual spend on other bought services (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.98	0.92	0.94	0.96	0.93	1.02	0.92	1.04	0.95	0.97
Telecommunications	0.12	Per capita annual spend on other bought services (weighted by decile) as a proportion of UK average.	ONS 2010[d]	0.96	0.98	0.92	0.94	0.96	0.93	1.02	0.92	1.04	0.95	0.97
Water supply	0.07	Per capita annual spend on water and sewerage (weighted by decile) as a proportion of UK average.	ONS 2010[d]	1.03	0.99	1.03	1.02	1.00	1.02	0.99	1.02	0.98	1.01	1.01
Sewage and sanitary services	0.33	Per capita annual spend on water and sewerage (weighted by decile) as a proportion of UK average.	ONS 2010[d]	1.03	0.99	1.03	1.02	1.00	1.02	0.99	1.02	0.98	1.01	1.01
Health and vet.services	0.62	Per capita spend on healthcare as a proportion of UK per capita average.	ONS 2010[d]	0.97	0.95	0.92	0.94	0.96	0.92	1.02	0.92	1.03	0.94	0.97
Education	0.41	Per capita spend on education (weighted by decile as a proportion of UK average.	ONS 2010[d]	0.85	0.68	0.54	0.55	0.59	0.55	1.10	0.52	1.20	0.64	0.79
Public admin. and defence	1.01	Average income as a proportion of UK average	ONS 2010[c]	0.87	0.96	0.85	0.88	0.92	0.87	1.03	0.82	1.26	0.88	0.93
Social work activities	0.22	Average income as a proportion of UK average	ONS 2010[c]	0.87	0.96	0.85	0.88	0.92	0.87	1.03	0.82	1.26	0.88	0.93
Structural clay products	0.00	Per capita spend on construction (weighted by decile as a proportion of UK average.	ONS 2010[d]	0.95	0.98	0.90	0.93	0.96	0.92	1.02	0.90	1.05	0.94	0.97
Cement, lime and plaster	0.01	Per capita spend on construction (weighted by decile as a proportion of UK average.	ONS 2010[d]	0.95	0.98	0.90	0.93	0.96	0.92	1.02	0.90	1.05	0.94	0.97
Articles of concrete, stone etc	0.01	Per capita spend on construction (weighted by decile as a proportion of UK average.	ONS 2010[d]	0.95	0.98	0.90	0.93	0.96	0.92	1.02	0.90	1.05	0.94	0.97
Structural metal products	0.01	Per capita spend on construction (weighted by decile as a proportion of UK average.	ONS 2010[d]	0.95	0.98	0.90	0.93	0.96	0.92	1.02	0.90	1.05	0.94	0.97
Construction	0.07	Per capita spend on construction (weighted by decile as a proportion of UK average.	ONS 2010[d]	0.95	0.98	0.90	0.93	0.96	0.92	1.02	0.90	1.05	0.94	0.97
Architectural and technical	0.00	Per capita spend on construction (weighted by decile as a proportion of UK average.	ONS 2010[d]	0.95	0.98	0.90	0.93	0.96	0.92	1.02	0.90	1.05	0.94	0.97
Dwellings	0.45	Per capita spend on construction (weighted by decile as a proportion of UK average.	ONS 2010[d]	0.95	0.98	0.90	0.93	0.96	0.92	1.02	0.90	1.05	0.94	0.97

8 Appendix D: Industry data

Attribute	Year	Unit	Bolton	Bury	Manc.	Oldham	Roch.	Salford	Stockport	Tameside	Trafford	Wigan	GM	UK
GVA (Work Place Based)	2010	£ (Millions)	4,254.2	2,667.0	13,919.1	3,025.4	3,232.4	4,770.6	5,735.5	3,209.0	5,633.2	4,300.0	50,746.4	1,295,663.0
GVA Agriculture	2010	£ (Millions)	3.6	4.3	4.2	2.9	3.7	4.7	9.8	5.1	4.3	11.7	54.2	9,715.0
GVA Extraction	2010	£ (Millions)	0.9	0.4	0.4	0.1	-	0.1	2.0	-	-	2.0	5.8	5,026.0
GVA Manufacturing (Total)	2010	£ (Millions)	593.7	316.3	719.0	458.0	515.0	396.5	583.0	574.0	572.0	620.0	5,347.5	150,298.0
GVA Food, Drink & Tobacco	2010	£ (Millions)	141.7	19.2	115.9	70.0	40.5	42.3	95.2	121.9	211.6	254.9	1,113.3	
GVA Textiles & Leather	2010	£ (Millions)	36.2	27.1	61.9	34.4	71.0	12.8	12.3	37.3	12.9	27.3	333.4	
GVA Wood & Wood Products	2010	£ (Millions)	5.0	2.0	3.6	10.0	9.0	10.0	5.0	6.0	6.0	18.0	74.6	
GVA Pulp Paper & Printing	2010	£ (Millions)	56.5	28.5	92.5	49.8	28.7	24.0	106.5	37.9	78.1	17.7	520.2	
GVA Coke, Oil and Nuclear	2010	£ (Millions)	-	-	1.0	-	-	-	4.0	3.0	11.0	-	19.0	
GVA Chemicals	2010	£ (Millions)	58.6	82.2	137.4	56.5	135.2	127.6	68.1	101.2	61.7	61.0	889.5	
GVA Rubber and Plastic Products	2010	£ (Millions)	47.7	44.5	31.4	21.6	46.4	15.7	25.2	36.7	17.7	34.8	321.6	
GVA Other Mineral Products	2010	£ (Millions)	11.9	8.3	13.8	4.8	5.4	37.0	7.3	20.3	29.2	27.4	165.4	
GVA Metals	2010	£ (Millions)	54.4	51.0	30.7	55.2	60.8	28.5	37.7	60.6	28.5	50.8	458.2	
GVA Machinery and Equipment nec.	2010	£ (Millions)	30.8	20.2	22.9	40.5	70.7	35.8	38.6	36.7	21.3	19.8	337.4	
GVA Electrical & Optical	2010	£ (Millions)	75.1	17.0	114.6	74.2	24.6	41.2	89.9	37.0	51.4	51.0	576.0	
GVA Transport Equipment	2010	£ (Millions)	29.1	2.8	68.5	12.2	7.9	4.4	72.5	22.1	21.3	30.0	270.8	
GVA Manufacturing NEC	2010	£ (Millions)	47.0	13.5	24.4	29.2	14.9	17.1	20.9	53.5	20.9	19.0	260.5	
GVA Electricity, Gas & Water	2010	£ (Millions)	21.5	5.7	17.7	36.0	12.0	35.3	24.0	13.0	24.0	32.0	221.1	21,342.0
GVA Construction	2010	£ (Millions)	265.3	134.1	229.5	209.4	186.6	288.5	615.5	189.9	317.6	345.5	2,781.8	80,756.0
GVA Distribution & Hotels	2010	£ (Millions)	591.2	382.5	1,701.1	458.0	407.4	568.6	755.9	452.3	904.0	586.2	6,807.2	183,586.0
GVA Transport & Communications	2010	£ (Millions)	265.8	232.6	1,635.0	136.0	339.3	285.1	369.4	139.0	366.3	296.0	4,064.4	91,347.0
GVA Financial & Business Services	2010	£ (Millions)	691.6	296.3	4,287.4	355.2	377.3	1,346.6	1,246.4	292.7	1,581.5	546.0	11,021.1	116,801.0
GVA Public Administration	2010	£ (Millions)	173.6	91.9	815.3	94.8	129.5	224.8	190.5	109.6	168.6	124.7	2,123.1	63,281.0
GVA Education & Health	2010	£ (Millions)	543.5	499.2	2,260.7	438.1	359.2	738.7	689.6	414.1	495.6	514.7	6,953.4	170,268.0
GVA Other Personal Services	2010	£ (Millions)	154.8	125.9	546.6	100.4	99.3	122.6	222.7	129.0	237.0	172.0	1,910.4	65,563.0
GVA Ownership of Dwellings	2010	£ (Millions)	354.8	261.5	983.4	278.3	288.5	362.6	443.5	316.0	390.7	437.5	4,116.8	303,179.0

*Source Greater Manchester Forecast Model.

9 Appendix E: Main data sources and references

Source	Links for sources
Audsley, E., Brander,M., Chatterton, J., Murphy-Bokern, D., Webster, C. and Williams, A. 2010 'How low can we go? An assessment of greenhouse gas emissions from UK food system and the scope for reduction by 2050'. WWF-UK.	
Booths, 2010, The Greenhouse Gas Footprint of Booths. A report by Small World Consulting Ltd.	http://www.booths.co.uk/Documents/Booths_Full_Report_100720.pdf
CAA (Civil Aviation Authority), 2011, Passenger Survey, [data purchased 25.5.11]	http://www.caa.co.uk (Bespoke dataset)
Defra, 2009/10, Annual Municipal Waste Stats, NI Waste Authority Stats (2009/10) [Accessed 6.6.11]	http://www.wastedataflow.org/
Defra, 2010[a], Guidelines to Defra / DECC's GHG conversion factors for company reporting [Accessed 6.6.11];	http://archive.defra.gov.uk/environment/business/reporting/conversion-factors.htm
Defra, 2010[b], Family Food Survey for 2009	http://archive.defra.gov.uk/evidence/statistics/foodfarm/food/familyfood/documents/index.htm
DfT (Department for Transport),2011, Vehicle Licensing Statistics: VEH105 - Licensed vehicles by body type, by local authority, Great Britain, annually: 2010	http://www2.dft.gov.uk/pgr/statistics/datatablespublications/vehicles/licensing/
DECCa Sub-national estimates of non gas, non electricity and non road transport fuels 2005, 2006, 2007 and 2008	http://www.decc.gov.uk/en/content/cms/statistics/regional/other/other.aspx
DECCb Sub-national gas consumption statistics 2009	http://www.decc.gov.uk/en/content/cms/statistics/regional/gas/gas.aspx
DECCc Sub-national electricity consumption statistics 2009	http://www.decc.gov.uk/en/content/cms/statistics/regional/electricity/electricity.aspx
ECOFYS, 2007. Factors Underpinning Future Action - A report for Defra.	
Greater Manchester Forecast Model District Data (New Economy Manchester)	http://neweconomymanchester.com/stories/1119-greater_manchester_forecasting_model [accessed 7.6.11]
IPCC, 2007. Climate Change: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment report of the Intergovernmental Panel on Climate Change. Cambridge, UK and New York, USA: Cambridge University Press	www.ipcc.ch
Lenzen, M., 2001. Errors in Conventional and Input–Output -based Life-Cycle Inventories. Journal of Industrial Ecology, 4(4):127-148	
Leontief, W., 1986. Input–Output Economics (2nd ed). New York: Oxford University Press	
Miller, R.E. and Blair, P.D., 2009. Input–Output Analysis: Foundations and extensions 2nd ed. Cambridge University Press.	
Nässén, J., Holmberg, J., Wadeskog, A. and Nyman, M., 2007. Direct and indirect energy use and carbon emissions in the production phase of buildings: An Input–Output Analysis. Energy, 32:1593-1602	
ONS (Office of National Statistics), 2010a. Input Summary SUT's for 2004 - 2008: 2010 edition. National Statistics online	http://www.statistics.gov.uk/about/methodology_by_theme/inputoutput/latestdata.asp
ONS (Office of National Statistics), 2010b. Environmental Accounts, Total GHG Emissions by 93 Economic Sectors, 1990 to 2004.	http://statistics.gov.uk
ONS (Office of National Statistics), 2010 [d] Family Spending 2010 (Living Costs and Food Survey 2009)	http://www.statistics.gov.uk/downloads/theme_social/familyspending2010.pdf
ONS (Office of National Statistics), 2010[d]Annual Survey of Hours & Earnings (ASHE)	http://www.statistics.gov.uk/pdfdir/ashe1210.pdf
Our Airports latitude and longitude airport data [Accessed 7.6.11].	http://www.ourairports.com/data/
Ranganathan, J., Corbier, L., Bhatia, P., Schmitz, S., Gage, P. and Oren, K., 2006. The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard (revised edition). Washington, USA: World business council for sustainable development and World Resources Institute.	
Stern, N., 2006. The Economics of Climate Change: The Stern Review. London: The stationary office on behalf of HM Treasury.	www.hm-treasury.gov.uk
UNFCCC, 1998. Kyoto Protocol to the United Nations Framework Convention on Climate Change. Kyoto: United Nations	
University of Bath, 2011. ICE (Inventory of Carbon and Energy) Version 2.0. Prof Geoff Hammond and Craig Jones.	http://people.bath.ac.uk/cj219/