BioRegional

LONDON SUSTAINABLE DEVELOPMENT COMMISSION

Capital consumption

the transition to sustainable consumption and production in London

November 2009

BioRegional

BioRegional is an entrepreneurial charity which invents and delivers practical solutions for sustainability. We develop sustainable products, services and production systems and set up new enterprises and companies to deliver them; initiate and guide the development of sustainable communities; and seek to replicate our approach through consultancy, communications and training. Our aim is to lead the way to sustainable living through practical demonstration.

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London Sustainable Development Commission (LSDC)

The London Sustainable Development Commission was established in 2002 to advise the Mayor of London on making London an exemplary sustainable world city.

The Commission is made up of individual experts from the economic, social, environmental and London governance sectors. Commissioners give their time voluntarily, promoting sustainable development, embedding sustainability into London wide strategies, and helping make sustainability a meaningful and understandable concept for all Londoners.

Commissioners include: John Plowman (Chair), Penny Bramwell; Chris Church; Paul de Zylva; Pamela Gardner; Adrian Gurney; Peter Head; Samantha Heath; Maria Lee; Shaun McCarthy; Sue Riddlestone; Robert Runcie; Richard Stephenson; Robin Stott; and Mike Tuffrey.

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LONDON SUSTAINABLE DEVELOPMENT COMMISSION

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Foreword

Sue Riddlestone, BioRegional

We all know we have to reduce carbon emissions and live within our fair share of the earth's resources. Scientists and politicians are finally united in saying it's time to take action. We all have an idea of where to begin by cycling, recycling and saving energy at home but the complete picture of a low carbon future is somewhat hazy. This report aims to throw it into sharp relief for Londoners, and we hope it will provide useful insights for anyone interested in sustainability.

The London Climate Change Action Plan showed how we can reduce carbon dioxide emissions arising directly from energy use in the city, for example from our homes and transport. But we are also partly responsible for emissions arising indirectly from things we consume that are produced elsewhere and this makes a big difference. An Oxford University study showed that the UK's direct, production CO_2 emissions fell by 8.5% between 1990 and 2003, so you would immediately think we're doing a great job! But the same study showed that when measured on the basis of total consumption, CO_2 emissions actually rose by 19%. Using this reality check, London's citizens are responsible for 90 Mt CO_2 per year – twice the 44 Mt CO_2 that can be attributed to London under a production approach.

A consumption-based approach is important if we are going to tackle climate change in an honest manner. It means we don't shift responsibility for reducing the carbon emissions of the goods we buy often from poorer countries, entirely on to them to solve or perhaps ignore.

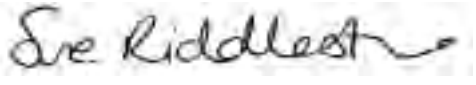
In London we consume three times our fair share of the earth's resources. That's why at BioRegional we talk about one planet living, and have been working with partners to show through sustainable communities and products how we can live high quality lives within these natural limits. In my other role at the London Sustainable Development Commission we have been working to find a way to make Sustainable Consumption and Production relevant and possible in London. This study is a natural and timely collaboration to show how London can live within its fair share.

Our study shows how London's carbon budget, which the science shows requires a 90% reduction in consumption emissions by 2050, can be achieved. We have looked at the total impacts of food, consumer goods, business and government procurement, and even the materials and processes involved in building our homes, offices and infrastructure. The measures shown would create many new businesses and satisfying jobs in London.

The study sets out where government can take the lead. For example, the Mayor, the Greater London Authority and the London Development Agency can plan for a city where we refurbish before we build new infrastructure and where public land and programmes are used to pilot truly innovative measures.

This report is a call to action for businesses, civil society organisations and citizens in London. Consider the solutions in this study and think about how to implement them in your own One Planet action plan, providing you with a roadmap to sustainable consumption. Every organisation can aim for Gold in the Mayor's Green Procurement code and be more efficient in their use of resources.

Together we can create a low carbon London and play a key role as one of the leading global cities responding to the challenge of sustainability.



Sue Riddlestone, Executive Director and co-founder, BioRegional and London Sustainable Development Commissioner

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John Plowman, LSDC

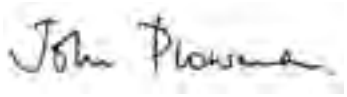
The London Sustainable Development Commission's vision is for London to be the global benchmark for sustainable development. This means a better quality of life for all Londoners, fostering a creative, cohesive and healthy society, and developing a dynamic and fair economy functioning within the limits of the planet. Crucially, it also means facing up to the global challenge of climate change.

Progress towards this vision is already underway, for example London's Climate Change Action Plan seeks to reduce carbon emissions within London by 60% by 2025.

The LSDC has been pleased to work with BioRegional to build on this progress by developing a clearer picture of London's contribution to climate change. This report does this in three important ways:

- It provides a recognition of the global impacts of consumption in London. The things we consume - from food to consumer goods to financial services – all have a carbon cost, regardless of where they are produced. Clearly, responsibility for these emissions is shared between the producers and the consumers – nevertheless, action within London to reduce its own impacts will make global efforts on tackling climate change more likely to succeed.
- The report also identifies a clear opportunity for leadership at the London level. Achieving big cuts in carbon emissions from consumption will not be easy, but it can be achieved through joined up action at all levels. London is ideally placed to help kick-start this action and support positive change both within and beyond its borders.
- Finally the report identifies the first steps towards achieving sustainable consumption which will not only help us meet the challenge of climate change but will also contribute to a better and healthier society underpinned by a smarter, more robust, economy.

The job of tackling excessive carbon production is to understand where it comes from and where it goes. We have largely ignored London's contribution to the problem as a consumer of resources until now. This report reveals the scale of the problem and importantly, what we can do about it. The LSDC looks forward to working with London's organisations and individuals to raise awareness of this issue and promote ideas for tackling it.



John Plowman, Chair, London Sustainable Development Commission

1 Executive summary

As a world city, London is a centre for the consumption of products and services and the movement of goods, people and finance. The consumption decisions made by people living in London have the capacity to affect people, economies and environments far beyond London's boundaries in both positive and negative ways. Positive examples include consumption of fairly traded products that support the livelihoods of producers in developing countries. Negative examples include goods consumed in London causing environmental damage overseas or having been produced with poor labour standards.

This report presents the rationale for using consumption based emissions and for a carbon budget approach to reducing London's carbon footprint by 90% by 2050.

The aim is to create an evidence base on the climate impacts of consumption in London, to provide a better understanding of the scale and breadth of action needed across all sectors to put London on a more sustainable footing, and to identify key opportunities for London to take effective action. The report takes an integrated approach to sustainable development, and so looks beyond CO_2 calculations to also consider the social, economic and health implications of the carbon saving measures.

Consumption in London results in approximately 90 million tonnes of CO_2 per year, compared with approximately 44 million tonnes when only energy and transport is counted (see Figure 2).

Facing up to the challenge

Confronting the issue of carbon emissions from consumption in London is important for 2 main reasons:

First, while current and predicted carbon-intensive patterns of consumption make London's own emissions targets harder to achieve they also threaten to undermine global efforts to tackle climate change- due to the heavy carbon content of goods consumed in London and produced elsewhere. Taking action in London is a way of recognising the extent of our collective responsibility and making global attempts to mitigate climate change more likely to succeed.

Second, addressing sustainable consumption and production (SCP) in London provides an opportunity for demonstrating leadership and creating positive change both within and beyond London. By influencing supply chains, supporting innovation and developing new business models for low carbon consumption, London can facilitate a shift to a more sustainable economy- in the UK and internationally. As well as reducing carbon emissions, this can bring benefits in terms of jobs, health and social wellbeing.

Leading by example

London is already at the forefront of climate change legislation with its groundbreaking Climate Change Action Plan, which maps out how London can achieve a 60% CO_2 reduction by 2025 in the energy, transport and built environment sectors. To ensure the success of these measures effort must also be focussed on reducing levels of consumption.

This report builds upon the actions already underway by identifying the wider climate impacts associated with consumption by London residents and maps out a route to more sustainable urban lifestyles within the city.

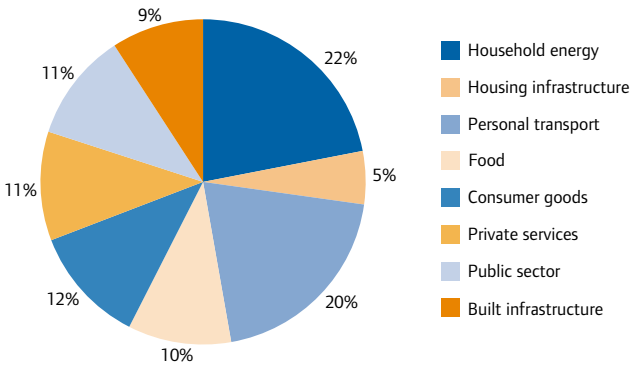
This report has the following particular characteristics:

- It models consumption based CO_2 emissions and so takes into account the embodied carbon emissions of items consumed in London but

manufactured elsewhere- such as consumer goods, construction materials and food
- It is London-specific and identifies opportunities for city-level action to catalyse change
- It considers CO_2 savings through changes in both consumption and production
- It uses a carbon budgeting approach to define the desired reduction pathway[1]

Modelling a transition

This report is particularly concerned with the climate change impacts of the goods and services consumed in London and splits London's carbon footprint into eight sectors, showing us where our impacts arise, see below.



It uses the metric of carbon emissions from consumption to assess London's current carbon footprint and to map out trajectories towards more sustainable consumption between now and 2050. The report uses modelling techniques based on resource accounting software to outline a possible set of measures that would achieve that pathway.

The results highlight the need to acknowledge that sustainable consumption can deliver wider economic, social and health benefits. Such gains are not automatic: an integrated and forward-looking approach to achieving sustainable consumption in London is needed.

Making it happen

The measures modelled in this report are stretching and ambitious, they are unlikely to be achieved by action only within London. As the supply chains and policy contexts influencing consumption in London are global in scope, responsibility for bringing about the measures must be shared between governments at all levels, businesses and consumers.

A key message from the modelling work in this report is that achieving major reductions in carbon from consumption will be challenging but it is possible.

Achieving these measures will need action at all levels- the Greater London Authority (GLA) and London boroughs, and national, EU and wider international businesses and non-governmental organisations, as well as Londoners themselves- to catalyse broader change, including mobilising purchasing power and procurement, programmes, planning policies, piloting and innovation, partnership and enabling and promoting sustainable lifestyles.

Finally, it is important to note that this report presents a model and an evidence base, not a manifesto. It is about choices. If particular measures are not progressed then others will have to replace them if the overall reduction target is to be met.

2 Sustainable consumption and production

Sustainable Consumption and Production (SCP) can be described most simply as "achieving more with less"[3]. It is an integrated approach that considers both ends of the supply chain for goods and services – supply and demand – including not only how they are produced but also how they are consumed. Sustainable consumption means considering the questions, "Do we need this commodity?", "Can we use less of it?" and "Can we choose a product or a service which has a lower environmental impact, and which is more durable?"

Sustainable production prompts questions like "Can we produce this product more efficiently, using fewer resources, or in ways which have fewer damaging effects?"

By looking at both aspects, we acknowledge the implicit connections between consumption and production. We acknowledge that we can reduce demand as well as improve manufacturing efficiency, and that both parties in the transaction, consumers and producers, will have a role to play in emissions reductions.

As part of its work on SCP, the London Sustainable Development Commission (LSDC) commissioned a review of national, international and regional approaches to SCP. The review found a range of different definitions, but there is a common recognition that "SCP refers to consumption and production activities that are resource efficient, that reduce the intensity of pollution, reduce costs, encourage economic progress and social benefits and that are accessible to the spectrum of citizens".

The LSDC concludes that SCP should support London's goal of becoming an exemplary sustainable world city by:

- Using the purchasing power of London's people and organisations to establish consumption patterns that achieve positive economic, social and environmental outcomes in London and beyond.
- Moving the production of goods and particularly services in London towards more resource efficient and socially beneficial processes.
- Promoting innovation and best practice in order to generate consistent economic progress through increasingly efficient production of more environmentally and socially positive goods and services.

SCP is a particularly important approach at the city level. Cities such as London are not only major consumers of goods and services but are also particularly vulnerable to price shocks from natural resources and to the burden that inefficient use of national resources places on the economy. Cities are also not only responsible for the majority of the world's CO_2 emissions but will be particularly exposed to the impacts of climate change, including sea level rise, flooding and overheating.

Why we have used a consumption-based model

There are several different ways of attributing responsibility for carbon emissions. The approach taken by most government targets (including the existing London climate change targets) is to assign responsibility on the basis of the geographical location of where emissions are produced or where energy is used, and consist of emissions from buildings, transport and industry that are emitted within certain boundaries. For example, the London Climate Change Action Plan deals with carbon dioxide emissions from within the greater London area, and those associated with electricity usage and transport emissions within London's borders[4].

Territorial or "production" emissions are widely used as they relate to activities taking place within the area being considered. However, calculations based on production emissions only tell a partial story about overall impact, as production emissions

do not include the impacts from goods and services consumed in London but produced outside it. For example, while energy use for heating, cooking and lighting in the home is considered, the energy used to produce food and consumer goods consumed by Londoners is not counted unless those goods were also produced within London's borders. These geographically based production emissions calculations can also leave unaccounted gaps, such as international shipping and aviation emissions that do not occur within national boundaries.

This report offers an alternative approach, focusing on consumption. It includes direct emissions from buildings and transport but looks beyond this to consider all the embodied CO_2 in goods, food and materials used by London residents. This includes the impacts of all the supply chains of products and services reaching households in London – including those emissions that occur elsewhere in the world on our behalf. Similarly, this calculation does not take account of London's business or industrial emissions where the end consumer of the goods produced is not a Londoner, as the focus is specifically on consumption by London residents.

To date, a considerable proportion of the emissions reductions achieved in developed countries like the UK have occurred through 'exporting' emissions abroad due to the relocation of heavy industry, rather than through a shift to lower carbon consumption and production in the UK. A study by Dieter Helm and colleagues at Oxford University found that although CO_2 emissions have fallen by 8.5% in the UK when measured on a production basis, when measured on the basis of consumption UK emissions rose by 19% between 1990 and 2003[5]. As a consequence, increasing proportions of emissions from developing countries and emerging economies are linked to exports for consumption by developed countries rather than to meeting their own development needs. Net exports from China, for example, represent 23% of its overall emissions[6].

This is unsustainable. If people in wealthier cities such as London retain a higher carbon footprint from consumption, other people in developing countries would have to reduce the carbon associated with their own consumption needs even further if a global cap on emissions is to be met. An integrated SCP approach can not only reduce direct emissions within London but also make it easier for other countries to achieve their own carbon reduction commitments and for a global limit on emissions to be set.

Similarly, without targeted efforts at reducing consumption emissions, significant improvements in efficiencies in production and distribution risk being outstripped by emissions increases from rising demand. Addressing consumption and production at the same time means that efficiency gains are more likely to result in a reduction in overall emissions.

The report allocates consumption emissions to the final consumer and shows how consumer demand drives production. This is not to say that the total responsibility for dealing with these emissions is down to the consumer. Rather, there is a shared responsibility between consumers, retailers, manufacturers and government in the UK and beyond to deal with these issues at all levels of the supply chain.

Figure 1 illustrates the difference between consumption based and territorial emissions, while Figure 2 shows the sector breakdown of each approach.

Figure 1: overlap between consumption and production emissions

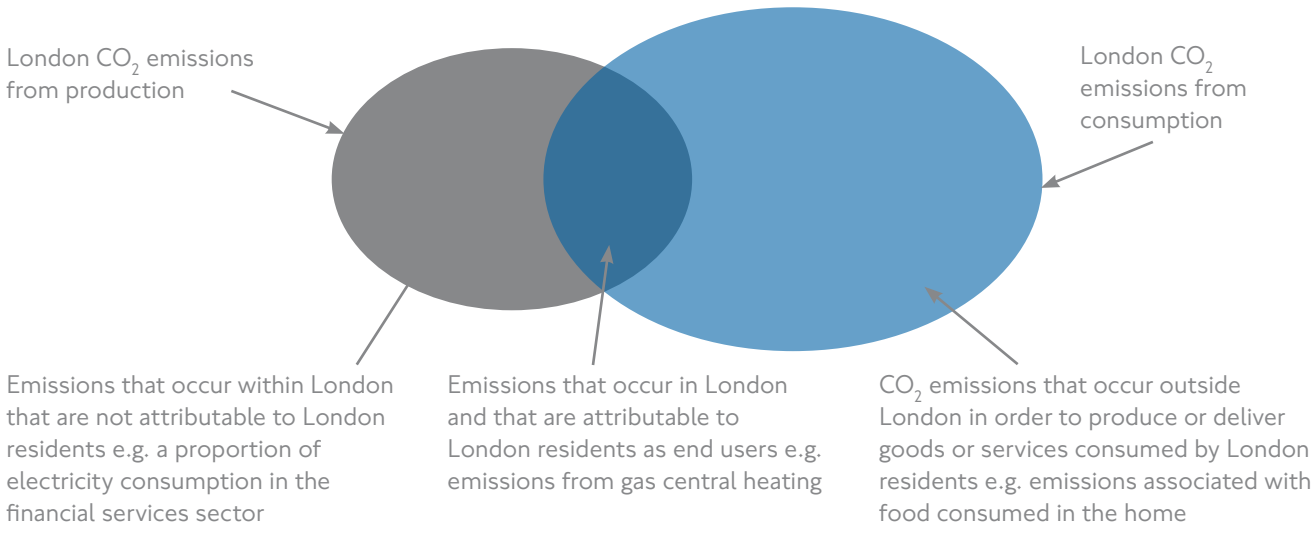
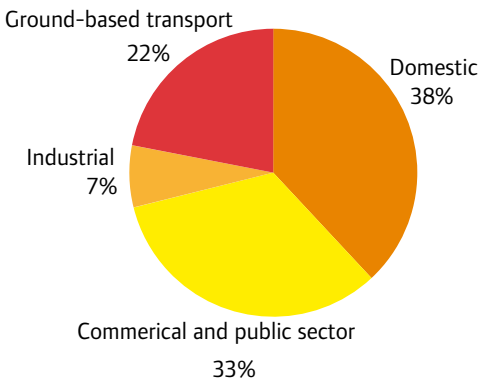
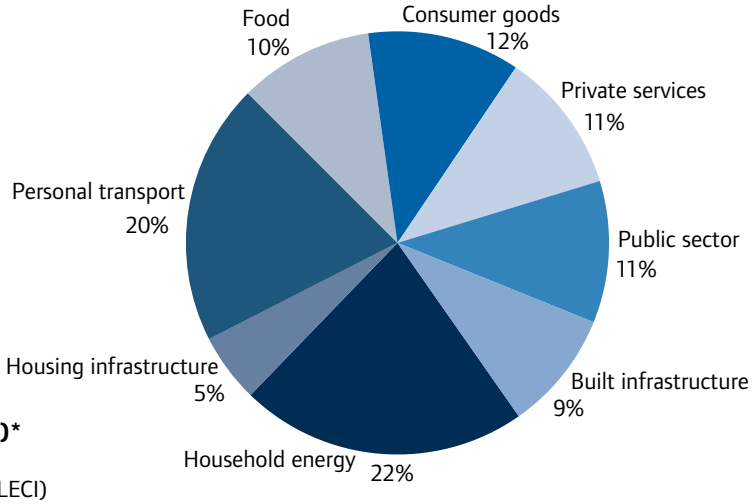


Figure 2: Breakdown of production and consumption emissions



CO2 from production (total: 44.3m tonnes)*
* Mayor's Climate Change Action Plan (2007). London Energy and CO2 Emissions Inventory (LECI) data (for 2003) projected to 2006. The latest London Energy and Greenhouse Gas Inventory (LEGGI) as detailed in the LSDC Quality of Life indicators report shows 45.3 million tonnes for 2004.



CO2 from consumption (total: 89.5m tonnes)**
** REAP v2 release based on 2004 data. Published by Stockholm Environment Institute 2008.

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3 Methodology

This report offers a possible scenario of how London can be sustainable in terms of consumption-based carbon emissions. It does this by:

- Benchmarking: establishing London's current emissions and predicted future trends
- Target setting: reviewing what carbon reductions are necessary and setting a reduction trajectory for London's emissions
- Sector analyses: establishing targets by sector that together deliver the total necessary reductions.
- Predicting reductions: reviewing existing policies and legislation for each sector to assess and quantify predictable CO_2 reductions
- Reduction Measures: developing a set of measures for each sector that will deliver the target reductions
- Identifying opportunities for city-level action to move London towards a sustainable carbon reduction trajectory and deliver social, economic and health benefits.

Benchmarking, sector analyses and quantification of reduction measures were all carried out using carbon accounting software REAP – the Resource and Energy Analysis Programme[7]. REAP was developed by Stockholm Environment Institute (York) as part of the Ecological Budget UK project. It is based on Material Flow Accounting for the whole of the UK, which establishes the total material flows in the UK economy and uses economic data to track the flows of material and provides a full account of the UK. The main data source for REAP is PRODCOM, a survey compiled by the Office for National Statistics on Products of the European Community. It is a harmonized system across the European Community for the collection and publication of product statistics. The data is then organised by final consumption patterns (which follow both SIC and the COICOP[8] classifications).

REAP can produce data by CO_2 emissions, Greenhouse Gas emissions and Ecological Footprint. The model mainly considers CO_2 emissions rather than the whole basket of greenhouse gases because the data surrounding CO_2 is more robust and because local authority and Greater London Authority (GLA) targets are based on CO_2. The exception to this is the food sector where the distinction between CO_2 and GHG emissions becomes more significant.

While REAP generates a good indicator of national and city-level carbon emissions from consumption, the methodology does have some limitations:

- Currently the data from REAP is not available in a time series for London, which makes it difficult to compare annual progress. However, time-series data has been developed for the UK as a whole which provides us with useful information about trends in consumption emissions as opposed to production emissions.
- The data provided is at a sectoral level, as opposed to a process-based Life Cycle Analysis dataset which is much more finely grained. LCA data is very useful for assessments of specific material or product choices. However, the input-output method allows us to avoid issues of overlap or gaps between datasets to enable total footprint assessment.
- The model derives a local authority's impacts from broad socio-economic rather than actual measured impacts in the local area, which makes it unsuitable for target-setting.

The initial results of the modelling work were presented at a stakeholder workshop in March 2009 to an audience of policy-makers at the national, regional and local level, academics, non-governmental organisations and business representatives[9]. The workshop helped to fine-tune the model and inform the evidence base behind the measures. It also helped to develop knowledge

on the social inclusion, health and economic implications of measures, and to identify not only existing programmes and activities that shape the SCP agenda but also gaps and opportunities for action at the city level.

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4 Benchmarking London emissions

Using the perspective of consumption, London is currently responsible for 90 Mt CO_2 per year – twice the amount that is attributed to London under a production approach. This is the equivalent to a carbon footprint of 12.12 tonnes CO_2 per year for every Londoner – similar to the national average of 12.08 tonnes CO_2 per person per year, but substantially higher than other regions such as the North East (11.14) and the West Midlands (11.53). Within London, carbon footprints also vary considerably -ranging from 10.03 in Newham to 13.99 in Richmond upon Thames[10] – which reflects the strong links between affluence and consumption levels and the greater reliance on private cars for transport in outer London.

Nationally, consumption-based accounts show increases over time, due to the export of heavy industry while domestic consumption is still rising. When measured on a production basis, UK greenhouse gas emissions have fallen by 18.4% and CO_2 emissions are down by 8.5% since 1990. However, as noted previously, when measured on a consumption basis, UK emissions rose by 19% between 1990 and 2003[11].

In addition to emissions that are largely covered by existing policy – such as domestic energy (22%) and personal transport (20%) – other significant sources of consumption emissions in London include consumption of consumer goods (12% of the total), food (10%) and the embodied emissions from the construction of built infrastructure (9%) and housing (5%).

The eight sectors are defined as follows:

- **Domestic energy** represents emissions from all gas and electricity consumption in homes, plus any other domestic fuels
- **Housing infrastructure** includes emissions from building and maintaining of our homes.
- **Personal transport** includes emissions from fuel consumption, vehicle purchase, public transport and flying.
- **Food** includes emissions from food and drink consumed at home or out at restaurants or other catering establishments.
- **Consumer goods** represents emissions associated with any products we purchase, including durable large household objects such as furniture and appliances and smaller products such as newspapers, clothing, electronics.
- **Private services** include emissions connected with any service that we consume such as recreation, financial, telephone, insurance, private schools and private medical care.
- **Public sector** includes emissions from central and local government, schools, universities, the National Health Service and other social services.
- **Built infrastructure** includes emissions from all investment in capital assets such as buildings and structures, factories, machinery and transport equipment - including both the business sector and government.

Business as Usual scenario

As well as mapping London's current emissions from consumption, a Business as Usual scenario has been developed to forecast London's future emissions if no further remedial actions are taken. The carbon reduction measures are then modelled against the BAU scenario.

Under the business as usual scenario, London's CO_2 emissions from consumption would increase by a third by 2050 (see Figure 4).

The Business as Usual (BAU) scenario assumes that per capita emissions remain constant but London's total emissions rise as London's population increases. The BAU scenario assumes no additional renewables, no change

in consumption patterns and no changes in efficiencies or technologies. Population data is taken from ONS 2006 and UK Government Actuary's Department predictions.

Figure 3: Breakdown of London's CO_2 emissions from consumption

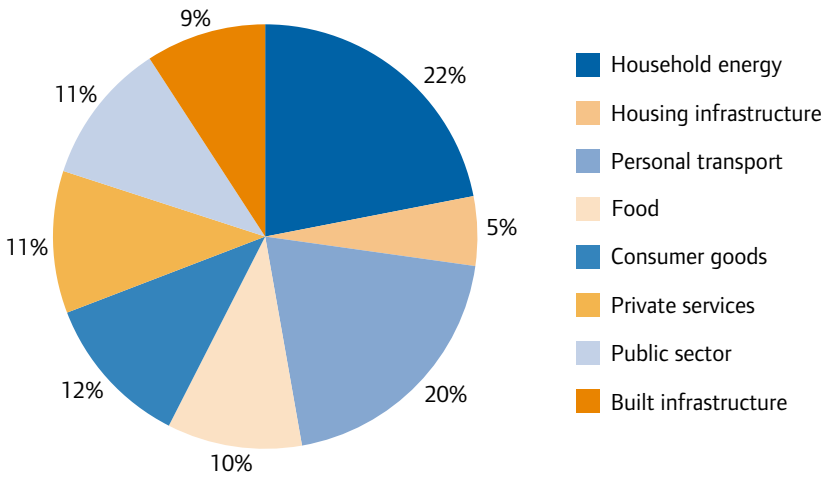
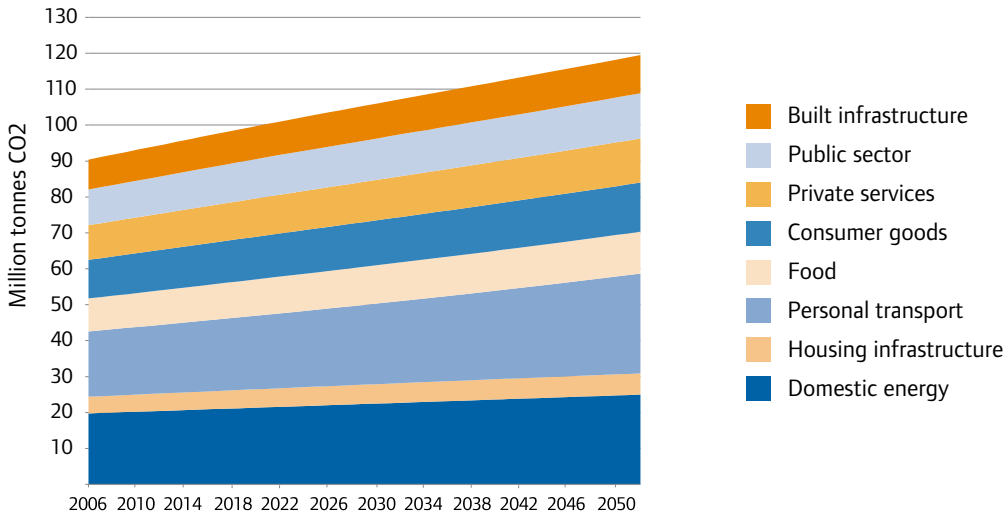


Figure 4: Business as usual trajectory modelled in this study for London's emissions



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5 What would a consumption-based carbon target look like?

Most climate change targets are based on concepts of a 'fair allocation' of carbon allowances within a 'safe' overall limit to avert dangerous climate change. This section applies the same principles to consider what an appropriate consumption-based carbon target for London would look like.

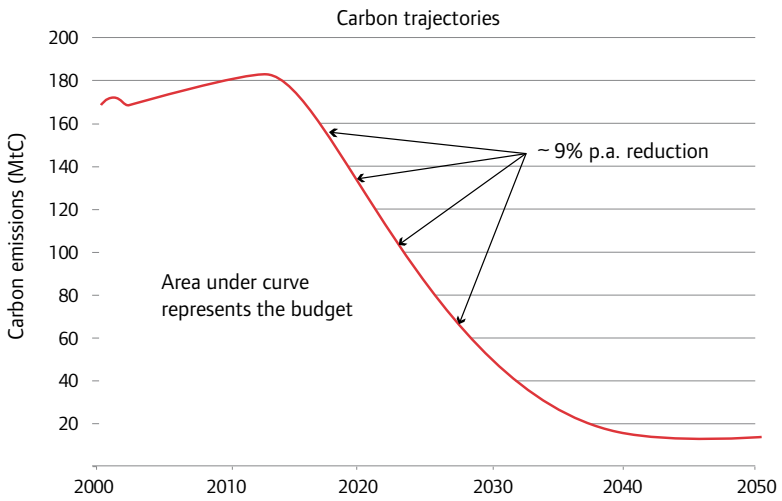
The UK Climate Change Act target of an 80% reduction in CO_2 by 2050 and the London Climate Change Action Plan target of a 60% cut by 2025 are both broadly based on a 'contraction and convergence' model in which by 2050 everyone in the world would be entitled to an equal share of emissions with the aim of atmospheric CO_2 concentrations not exceeding 450ppm. This entitlement is roughly equivalent to two tonnes of CO_2 per person each year. As UK and London emissions are currently much higher than this (whether calculated on a production or consumption basis), the targets are based on the reductions needed to achieve an equitable level by 2050.

However, the degree of warming will depend not on meeting a percentage emissions reduction by a specific date but on the atmospheric accumulation of greenhouse gases over time. Put simply, it's not just the level of emissions in 2050 that counts, but the total cumulative emissions between now and then – and the steepness of the carbon reduction trajectory.

For this reason, a 'carbon budgeting' approach is used by the UK government and has been used in this report. The carbon budget defines the total amount of CO_2 that can be emitted between now and 2050. Emitting more now means that greater reductions will be needed in future to compensate: as seen in Figure 5, ***it's the area under the curve that counts***. The slower emissions cuts are made, the harder it then becomes to stay within this budget and the steeper the cuts that will be needed later. This approach is set out in the Tyndall Centre's 'Living within a Carbon Budget'[12] and has also been used to inform the Committee on Climate Change recommendations and the CCAP.

The Tyndall Centre work develops a target trajectory rather than a linear pathway to stay within the carbon budget (see Figure 5). This is based on the recognition that there will be a degree of emissions 'lock-in' from our existing

Figure 5: UK carbon budget modelled by Tyndall Centre



infrastructure and economy that means that steep reductions will take some time to achieve. Similarly, it recognises that emissions reductions will become progressively more difficult in future years once the main sources of emissions have been addressed.

The approach taken within this report is therefore based on the following principles:

- Atmospheric concentrations of CO_2 stabilised at 450ppm or below
- Contraction and convergence by 2050 with everyone in the world entitled to the same carbon allowance
- A carbon budget approach, using the trajectory suggested by the Tyndall Centre.

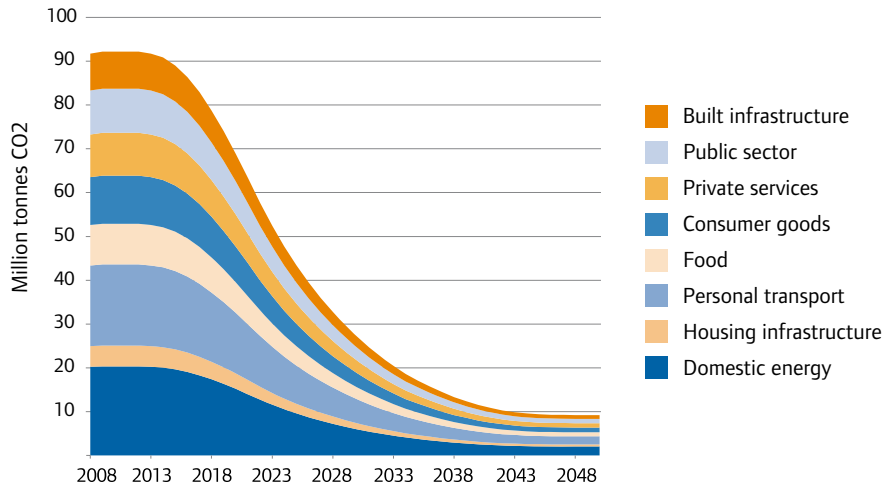
Based on these principles, an indicative target of a reduction in consumption-based emissions of 70% by 2030 and 90% by 2050 is suggested and was used for the scenario modelling in this report. This gives a total budget of 2.4 billion tonnes of CO_2 until 2050. Although there are many possible trajectories to meet this budget, the model in this study adopts the curve proposed by the Tyndall Centre as the most realistic scenario (see Figure 6).

The same trajectory was used in the model for each sector: we did not assume a different allocation for food or consumer goods, for example.

The emissions reductions implied by this model go beyond those set out by the London Climate Change Action Plan. This is because the model starts from a higher baseline: London's CO_2 emissions from consumption are nearly double those measured solely according to gas, electricity and transport emissions within London. As such, it relies upon concerted efforts at all levels – from manufacturers and suppliers to consumers and local, regional, national and international government – rather than interventions within London alone.

While this makes the trajectory more difficult to achieve, action on consumption emissions is necessary to make global action on climate change both equitable and effective. As noted above, a considerable proportion of the emissions reductions achieved to date in developed countries have occurred through 'exporting' rather than through lower carbon consumption and production. Contraction and convergence works on the

Figure 6: Target reduction trajectory modelled in this study for London's emissions



principle that everyone is entitled to emit the same amount of carbon under a global cap. This means that continued high levels of consumption emissions in wealthier cities such as London would require developing countries to reduce the carbon associated with their own consumption needs even further if a global cap on emissions is to be met.

In common with the approaches set out by the Committee on Climate Change, the Tyndall Centre and the CCAP, this trajectory is consistent with global greenhouse gas concentrations stabilising at 450ppm. It is worth noting, however, that stabilisation at 450ppm gives only a 50% chance of avoiding temperature rises in excess 2 degrees over pre-industrial levels[13]. A number of experts, notably NASA scientist and IPCC member James Hansen, have proposed that stabilisation at 350ppm (well below current concentrations of 387ppm) will be necessary in order to reduce climate change risks to an acceptable level[14]. No UK carbon budget has yet been modelled that would be consistent with a 350ppm stabilisation. However, given these developments in climate science, carbon targets should be kept under frequent review to ensure they are consistent with the latest scientific understandings of avoiding dangerous climate change.

6 Modelling emissions reductions

This chapter sets out the results of the modelling work to show one way in which a 90% reduction in consumption emissions could be achieved by 2050. The measures incorporate action by all stakeholders, from international bodies and national and local governments through to consumers and businesses. The measures modelled will be challenging to achieve, but are based upon the best available evidence of carbon reduction potential. A full discussion of the sources and assumptions behind the measures for each of the eight sectors is included in Appendix A.

First, we review the cross-cutting theme of grid electricity and how it has been treated within the model. The following eight sections then present the measures modelled for each of the eight specific categories. For each sector, the Business-as-Usual breakdown is established. Then the carbon savings from overarching decarbonisation of the grid electricity are applied. A series of further CO_2 reduction measures are modelled to demonstrate a pathway to meeting the targets. The measures are based on a combination of:

- Current policies and legislation, including the London Climate Change Action Plan
- Potential future measures
- CO_2 reductions necessary to meet the target trajectory

Decarbonisation of grid electricity – a cross-cutting measure

The UK's electrical supply relies mainly on remote centralised power stations which use fossil fuels or nuclear power to generate electricity. Opportunities for making use of the waste heat from these plants are limited because they are so far from population centres. These heat losses, combined with transmission losses in the grid, make the system inherently inefficient.

The issue of the efficiency of power generation and the carbon content of grid electricity cuts across all of the sectors modelled here. Goods and services produced using electricity based upon inefficient coal-fired power plants will clearly have a higher carbon footprint than if the electricity was predominantly sourced from renewables or other low carbon sources. Hence, decarbonising grid electricity will assist in achieving emissions reductions in each of the eight sectors modelled.

The model presented here incorporates the potential for reducing the grid's carbon intensity in two stages:

- Reductions in line with current policies
- Further potential reductions in line with Committee on Climate Change 90% reduction recommendations

These two measures are described here and then applied to each sector below.

1 Reductions in line with current policies

EU Renewable Directive

As part of the EU Renewable Directive, the UK has agreed with other Member States to an EU-wide target of 20% renewable energy by 2020. This target includes all energy i.e. grid electricity, transport fuels and heating.

The UK's share of this agreement is to achieve 15% of the UK's energy from renewable sources[15]. This constitutes an almost ten-fold increase in renewable energy generation from where we are now.

In 2000, the UK Government set a target of 10% of electricity supply from renewable energy by 2010. In 2006, they announced an aspiration to double that level by 2020. As of 2007, 5% of the UK's electricity supply came from renewable sources.

The UK Renewable Energy Strategy (RES) [16] looks at how the UK can achieve its commitments under the EU Renewable Directive. It assumes we will be aiming for 30% of our grid electricity from renewable sources by 2020 and that 10% of road transport fuels will come from renewable sources.

Beyond 2020, there are no stated policies on grid mix or carbon intensity. However, the government is committed to making significant improvements, as implied in the RES and the Climate Change Act.

In predicting the CO_2 savings from current energy policy, the model in this study assumes that:

- The UK Renewable Energy Strategy is successfully implemented and achieves a 30% renewable electricity mix by 2020
- Beyond 2020, the move towards renewables will slow down but a 50% target is reached by 2050. (This is broadly consistent with the CCAP hopes for the carbon intensity of the grid.)

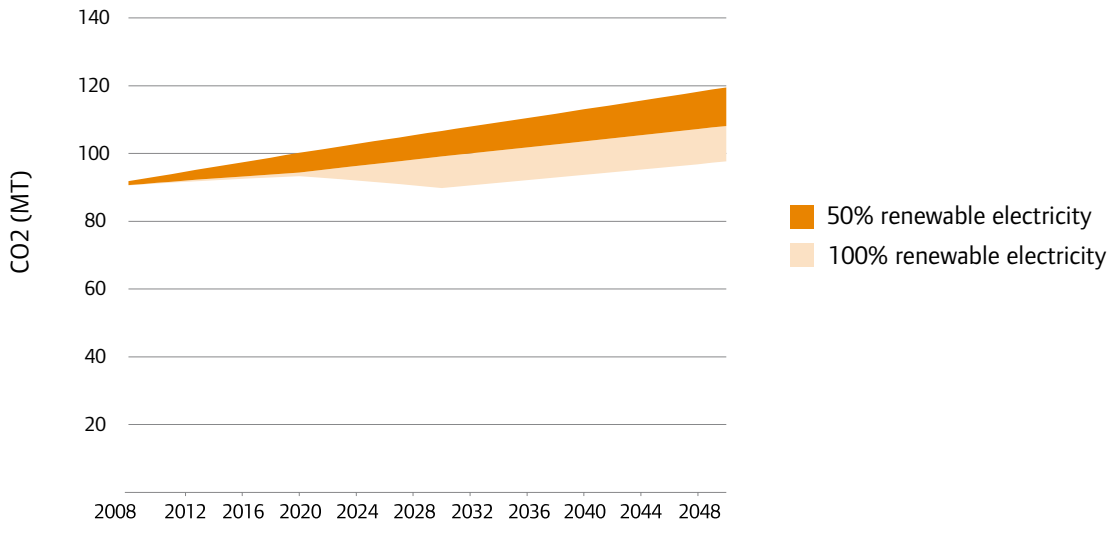
This scenario gives a 10% saving in total CO_2 emissions by 2050. It represents an annual saving of 11.4Mt CO_2 in 2050 relative to the business as usual scenario.

2. Further reductions in line with Committee on Climate Change 90% reduction recommendations

The UK Government appointed Committee on Climate Change report has analysed how far we can go towards decarbonising the UK economy. This is part of their work to inform the implementation of our targets set out in the UK Climate Change Act (2008) and our carbon budget announced in the national budget in April 2009.

Their report says: "Two key conclusions can be drawn: First that 80% to 90% cuts in domestic CO_2 emissions are feasible: Second that the radical decarbonisation of the electricity generation by 2030 is vital. There are no feasible scenarios which assume a more than trivial level of conventional (non CCS) fossil fuel plant on the system after the mid 2020s."[17] The Committee developed scenarios for both an 80% and a 90%

Figure 7: Emissions savings due to increasing renewable energy in the electrical grid



carbon reduction by 2050. In both scenarios, the carbon intensity of the grid needs to reduce from current levels of around 500g CO_2/kWh down to 40-70g by 2030 and to 20-35g by 2050.

The carbon intensity of electricity generation in the UK has already fallen significantly from 720g CO_2/kWh in the 1990s due to decommissioning inefficient old coal fired power stations, increased use of newer gas-fired power stations, imports of electricity from France's nuclear generation, and improved efficiency from the UK's nuclear generation.

In predicting the CO_2 savings from realising the Committee on Climate Change 90% reduction recommendations on grid electricity, the model in this study assumes that:

- the UK Renewable Energy Strategy is successful and achieves a 30% renewable energy grid mix by 2020
- the Committee on Climate Change 90% reduction scenario is followed which entails near total decarbonisation of the grid by 2030. It requires a 95% renewable grid mix by 2030, and 100% renewable by 2050.
- successful development of "balancing technologies" with sufficient capacity to cope with the more intermittent power supply from wind and other renewables.

This scenario gives an 18% saving in total CO_2 emissions in London by 2050. It represents an annual saving of 21.9 Mt CO_2 in 2050 relative to the business as usual scenario (Figure 7).

The following eight sections set out a scenario for reducing CO_2 emissions by 90% in each of the eight sectors.

Food

10%

Food consumption is responsible for 10% of London's consumption-based CO_2 emissions and 19% of greenhouse gas emissions.

Unlike other sectors, non- CO_2 greenhouse gas emissions are particularly significant for the food sector, and total greenhouse gases are about over twice as high as CO_2 alone (see table below). This is specifically caused by methane from livestock and nitrous oxide emissions from soil due to processes such as synthetic fertiliser application, leachate, animal wastes and manure application.

Table 1: GHGs from food

	Greenhouse gases (Mt CO_2eq)	Carbon dioxide (CO_2) (Mt)
Food	14.0	4.2
Non-alcoholic beverages	1.1	0.6
Alcoholic beverages	0.9	0.5
Catering services	5.7	3.7
Total food	**21.8**	**9.0**
Proportion of total	**19%**	**10%**

A breakdown of food emissions by food type is shown in Figure 8.

For this model, the Food sector includes any food or drink that individuals buy for their own household consumption. It includes food consumed at home, from the take-away or eaten at a restaurant. It does not cover food purchased by businesses or public sector services. For example, it does not include:

- Employees putting meals on expenses (becomes a cost of that business, and therefore trickles down to the total impact of the goods or services that the business provides)

Figure 8: Greenhouse gas emissions associated with food types

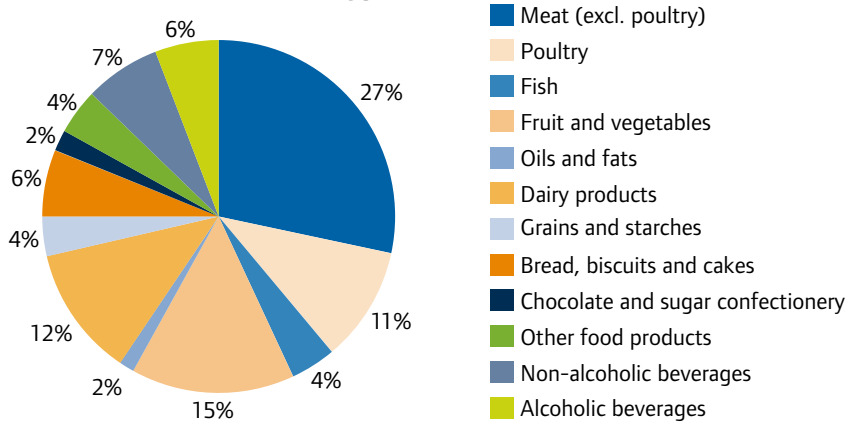
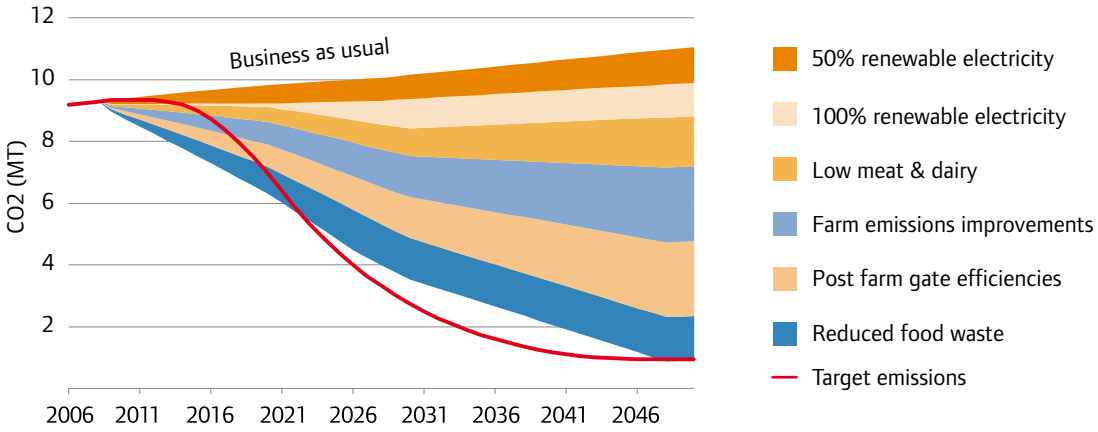


Figure 9: Measures to deliver emissions reductions from food



- Food supplied as part of the service sector, such as hospitals and care homes
- Food provided at conferences or business lunches

The total impact of measures to reduce CO_2 or GHGs in the food supply chain will therefore be more significant than this model suggests. An EU report[18], for example, estimates food to be responsible for around 31% of Europe-wide GHG emissions. For the UK, the FCRN report[19] estimates food to be responsible for 16.7% of GHGs from consumption.

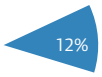
In the London context, the GLA's London Food Sector Greenhouse Gas Emissions report examines the distribution of GHG impacts through the supply chain of food sold within London[20]. It shows that 43% of the emissions come from the agriculture stage, 15% from manufacturing, and 20% from transport, storage and distribution. These three stages account for over three quarters of the emissions associated with food.

Figure 9 shows a set of measures that would deliver the CO_2 savings needed in this sector. In addition to decarbonisation of grid electricity,

the measures include action on the production and distribution side, and also changes to patterns of consumption. The food industry can improve efficiencies on farms, during processing, transportation and at the retail or catering establishments. Individuals can make a difference by cutting out food waste. Diets lower in meat and dairy help to cut carbon in addition to being compatible with healthy living agendas. The CO_2 reduction measures in this model are mainly based on the Food Climate Research Network study which concludes that an overall 70% reduction in emissions should be possible by 2050.

The detail behind the modelling is set out in Table 8 of Appendix A.

Consumer goods



Consumption of consumer goods accounts for 12% of Londoners' carbon footprint. The category of consumer goods covers the full range of physical items that London residents purchase (excluding food and cars). Therefore it covers everything from small day-to-day items such as newspapers to large household appliances or tools.

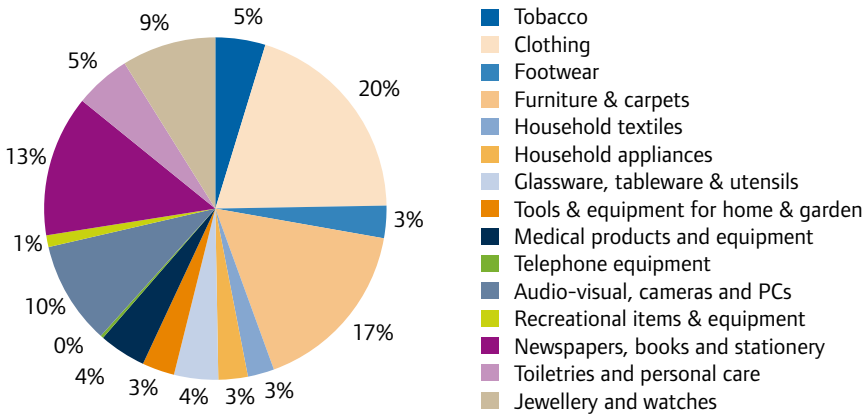
Figure 10 shows the breakdown of emissions from consumer goods purchased by London residents.

Clothing makes up a fifth of the consumer goods impact, followed by furniture and carpets which with nearly another fifth. Newspapers and books make up 13%, followed by audio-visual and computer equipment which comprises another 10%.

Goods consumed within London are produced all over the world; hence this category goes wider than just the goods that are produced within London's borders. The exact overlap between production emissions from goods and consumption emissions is not known; however given the decline in London's manufacturing industry it is likely that the majority of these goods are produced elsewhere.

To understand the climate impact of consumption of consumer goods, it is important to acknowledge that carbon emissions are associated with different stages of the supply chain, and therefore carbon savings can be sought in each. Individual lifecycle assessments of consumer products (e.g. carbon footprinting by the Carbon Trust) profile where emissions occur in the supply chain. There is no overarching assessment of the consumer goods sector as a whole but examples are shown below of two typical products: a white T-shirt and a bottle of shampoo (Figure 11). In the case of the white

Figure 10: Carbon emissions associated with consumer goods consumption



T-shirt, 65% of the impact is in the agricultural stage. For the shampoo, more than half of the emissions arise from raw material extraction.

It is also important to understand that the way waste is dealt with will have a significant impact on the carbon footprint of consumption. REAP models the total lifecycle of products in the Consumer Goods category. The waste impacts of the end of life of goods (i.e. the waste management of those goods) are measured in REAP as part of the total impact of those goods.

There are significant carbon benefits from diverting various different waste types away from landfill. The more energy intensive a material is to produce (e.g. aluminium), the greater the benefits of recycling due to displacement of virgin materials. The basic principle behind waste policy for London should be to maximise the carbon benefits, rather than recycling to meet weight based targets.

A carbon-based waste policy would mean, for example, that it is better to keep glass colour-separated and recycled in a closed loop rather than

Figure 11: Carbon footprints of a shampoo and a white T-shirt

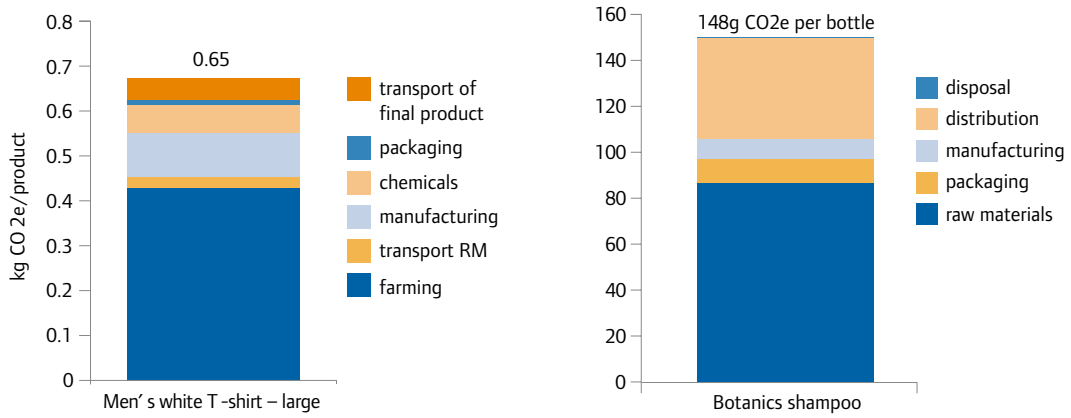
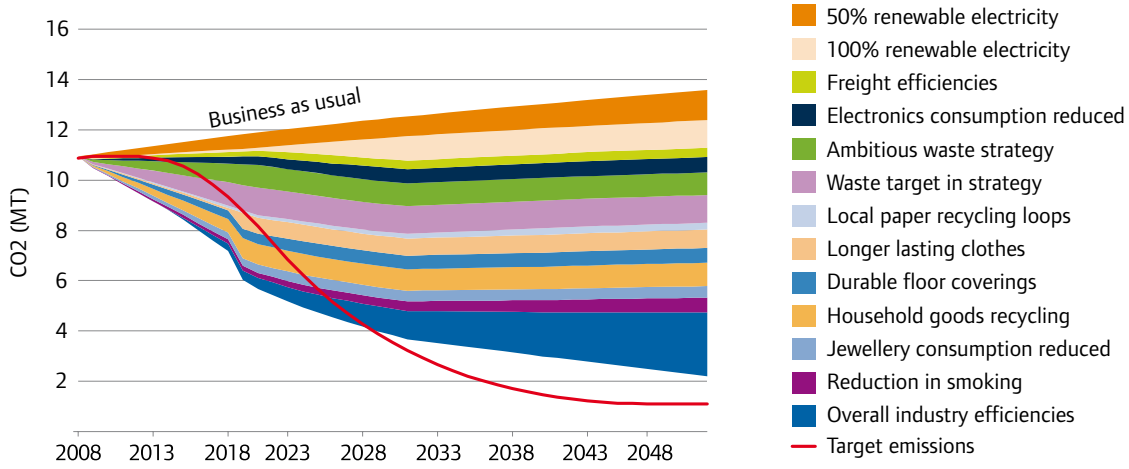


Figure 12: Measures to deliver emissions reductions from consumer goods



crushing for aggregate[21]. It also means following a 'waste hierarchy': promoting reduce and reuse, then recycling using closed loops. Down-cycling or energy recovery should be considered later due to the loss of carbon benefits.

Figure 12 shows where the CO_2 savings can be made in the goods sector through manufacturing efficiencies, freight efficiencies, greater use of the waste hierarchy and also, in some cases, reduced consumption. The detail behind the modelling is set out in Table 9 of Appendix A.

Private Services

Private Services are responsible for 11% of Londoners' carbon emissions from consumption. This sector covers the full range of services that London residents purchase. It includes banking, insurance, telecom services, private hospital or education, going to the theatre, mortgages, estate agents etc (see Figure 13). It does not include personal catering services (covered under Food), personal transport or those services provided by government.

Consumption of private services in London may have impacts throughout the world. The call centre for a mobile phone may be in India. An insurance company's impacts may include purchase of a new carpet produced in China to replace the flood-damaged carpet in a London home. Hence emissions from consumption of private services arise not only from onsite office energy consumption but also from less obvious impacts further down the supply chain.

Figure 14 shows how the carbon reductions in this sector can be achieved through energy efficiency of buildings and premises, through resource efficiency, through procurement policies and through long-term development of alternative fuels. The detail behind the modelling is set out in Table 10 of Appendix A.

Within this sector, there is very little data available on the breakdown of indirect CO_2 emissions. This makes it difficult to be specific about reduction measures for these emissions. The 'resource efficiencies, procurement policies & alternative

Figure 13: Emissions from consumption of private services

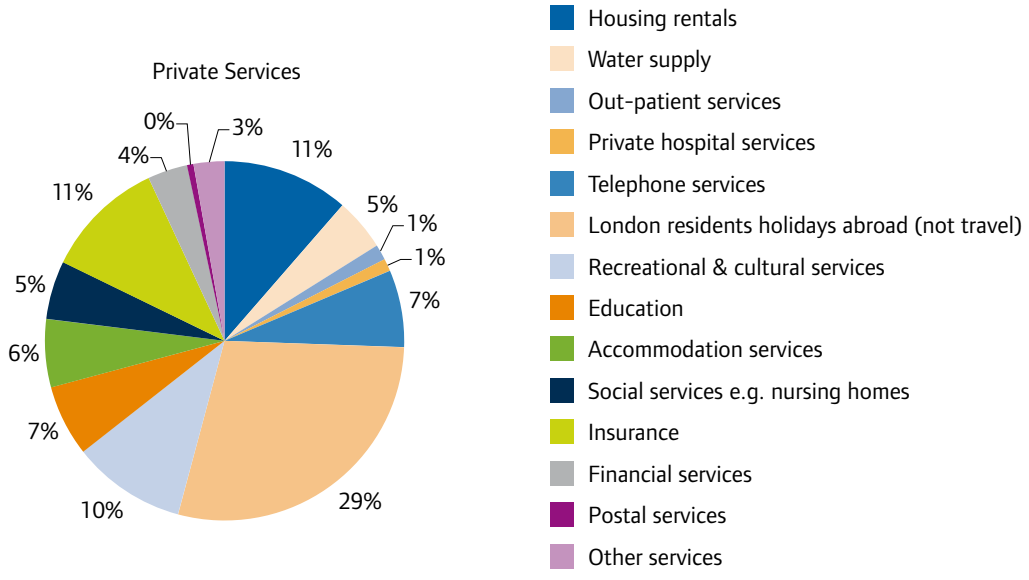
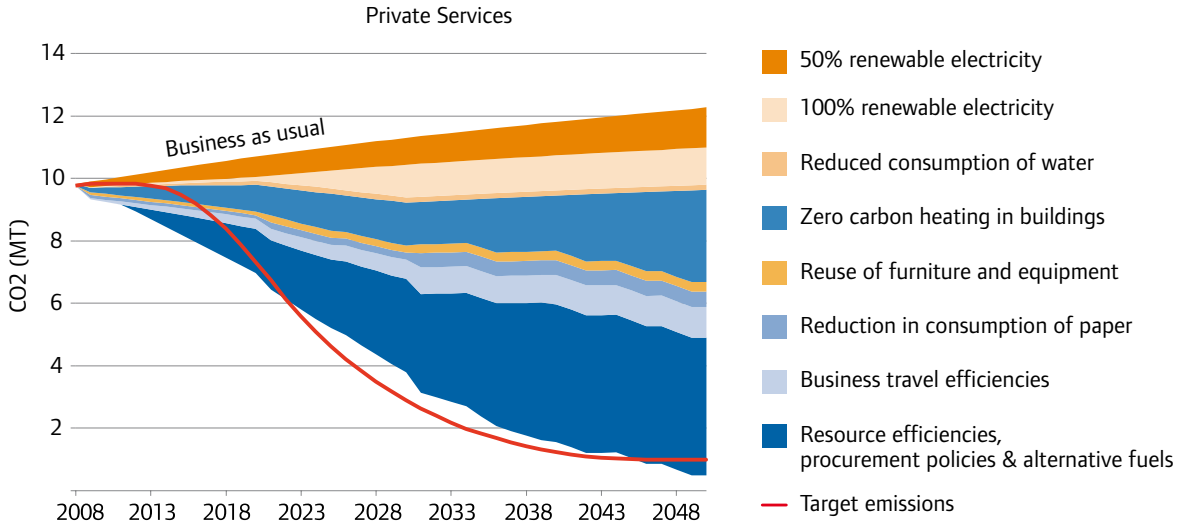


Figure 14: Measures to deliver emissions reductions from private services



fuels' measure in Figure 14 represents a wide range of measures in many different parts of the supply chain that collectively may be able to achieve the reductions required.

The private services sector generally has lower impacts per pound spent than the food or consumer goods sector[22]. In many ways, a lower carbon economy may necessitate a switch to a more service based economy. In addition, many private services would be perceived as essential by the consumers purchasing them, for example insurance, financial services or water supply. Therefore, with the exception of water saving measures, the CO_2 saving measures proposed are based around efficiencies within the company rather than reduced consumption of services within this sector.

Built infrastructure

9%

Built infrastructure accounts for 9% of London's consumption based CO_2 emissions. Roughly 70% of these emissions are embodied in the extraction, manufacture and delivery of construction materials. This chapter looks at all construction activities except for housing, which is considered separately and accounts for just 21% of the construction industry emissions.

This sector is accounted for in REAP by measuring the capital investment in tangible capital assets. This mainly covers construction of buildings, factories and other large infrastructure projects such as railways and motorways. This chapter considers capital investment in all sectors apart from domestic dwellings. These are considered separately in the Housing Infrastructure chapter because house-building policy is an interest area with unique issues to consider.

House building represents 21% of the total built infrastructure sector whilst commercial private office premises represent around 15%. Wholesale and retail represent a further 13% and the remaining 51% is spread across a wide range of industrial, infrastructure and utilities industries.

All sectors invest in built infrastructure. Table 2 shows the breakdown of infrastructure investment amongst all industry sectors[23], excluding Housing.

Table 2: Impact of infrastructure investment: all industry sectors excluding housing

Sector	% of total
Real estate, renting, office premises	15.5%
Post and telecommunications	8.2%
Retail trade	6.8%
Wholesale trade	6.1%
Other services	4.9%
Financial intermediation	4.1%
Hotels and restaurants	3.9%
Extraction - oil and gas	3.6%
Transfer costs for land, etc.	3.1%
Public administration	3.0%
Electricity	2.9%
Motor vehicles sales and repairs	2.8%
Other transport services	2.8%
Sewage and refuse disposal	2.4%
Chemicals, man-made fibres	2.3%
Transport equipment	2.3%
Food, beverages, tobacco	2.1%
Other land transport	2.1%
Health and social work	2.1%

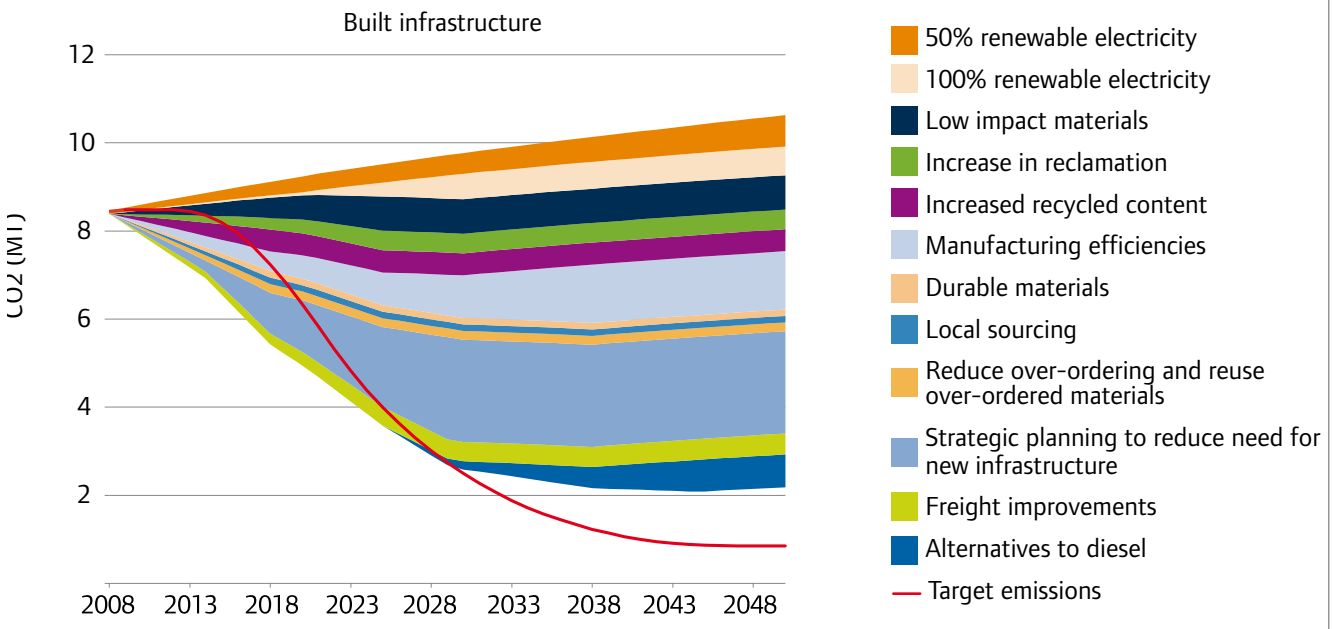
Sector	% of total
Construction	1.9%
Education	1.9%
Electrical and optical equipment	1.8%
Pulp, paper printing and publishing	1.8%
Air transport	1.7%
Agriculture; forestry and fishing	1.4%
Other manufacturing	1.4%
Basic metals and metal products	1.0%
Water	1.0%
Roads	1.0%
Machinery and equipment	0.8%
Other non-metallic minerals	0.6%
Gas	0.6%
Solid and nuclear fuels, oil refining	0.5%
Water transport	0.4%
Valuables	0.4%
Other mining and quarrying	0.3%
Textile and leather products	0.3%
Rail transport	0.1%
Total	**100.0%**

London's construction sector is currently worth £34 billion, 29% of the UK total for the sector. This shows that a very significant proportion of the UK's construction occurs in London. The consumption-based model being used in this study will mean that not all of this 29% will be attributed to London, as much of the infrastructure is used by people other than London residents. Built infrastructure is considered a shared resource amongst all UK residents and so is divided equally between all UK residents, despite the concentration of built infrastructure construction within London. However, any policies that London government make relating to construction will affect all London activity in this sector and may lead to greater carbon reductions than shown in this model.

Figure 15 shows a combination of measures could deliver the required CO_2 savings for this sector. Measures could include shifts towards lower impact materials and more durable materials. They include improvements to construction waste management services and in the longer term, there is a measure to make carbon savings on construction sites through low carbon diesel alternatives.

The measures also include a significant saving through strategically considering the most efficient ways in which to provide all of the infrastructure we need and thereby reducing the need to build at all in some cases. The measure includes a shift from new build to refurbishment. It allows for greater urban densification in preference to

Figure 15: Measures to deliver emissions reductions from built infrastructure (excluding housing)



development in areas in need of infrastructure. It also allows for increased investment in capital renewable energy schemes and public transport.

Although the chart shows emissions in 2050 to be above the target trajectory, the model still succeeds in staying within the target carbon budget by making early savings between now and 2025. The detail behind the modelling is set out in Table 11 of Appendix A.

Housing infrastructure

Housing infrastructure accounts for 5% of London's consumption based CO_2 emissions. Of this, 74% is from building new homes whilst 21% is for maintenance and repair of existing homes. This sector includes both the impacts of the construction industry when building new housing, and also the purchase of goods and services for the maintenance and repair of a dwelling e.g. roof repairs, window replacements etc. This sector does not include the emissions from energy consumption in homes, but looks at the embodied emissions from constructing and maintaining them.

Figure 16 shows a combination of measures that result in the required CO_2 savings for this sector. Similar to the built infrastructure sector, measures include shifts towards lower impact materials and more durable materials. They include improvements to construction waste management services and in the longer term, there is a measure to make carbon savings on construction sites through low carbon diesel alternatives. The model includes continuing to build homes at the current rate until 2025, then a shift from new build to refurbishment of existing homes as we have assumed a reduction in the need for new homes due to changing demographics and greater refurbishment of existing buildings. The detail behind the modelling is set out in Table 12 of Appendix A.

Table 3: Emissions from housing infrastructure

	CO_2 (million tonnes)	%
Goods and services for routine household maintenance	0.224	5%
Maintenance and repair of the dwelling	0.980	21%
Construction of dwellings	3.369	74%
Total	**4.573**	**100%**

Table 4: Emissions from the public sector

	M tonnes CO_2	%
Public administration (central)	3.22	33%
Health services	2.75	28%
Public administration (local)	1.39	14%
Education	1.13	12%
Other services (social work, sanitary and recreational)	1.29	13%
Total	**9.78**	**100%**

Public sector

The public sector accounts for 11% of London's consumption based emissions. For the model in this study, this sector covers local, regional and national government. It also covers health, education and other local services. This sector includes all operations of government, including transport emissions, building emissions and emissions associated with goods and services procured by the government at all levels. The table below shows the breakdown amongst the main government services.

The REAP model used in this study does not specifically examine the emissions associated with government offices based in London. Rather it examines the emissions associated with the total impact of UK government and allocates it on a per capita basis. Therefore, the emissions described above illustrate London's share of both local and national government emissions. This allocation method means that the model does not disproportionately penalise London for being the location of the national government.

Figure 16: Measures to deliver emissions reductions from housing infrastructure

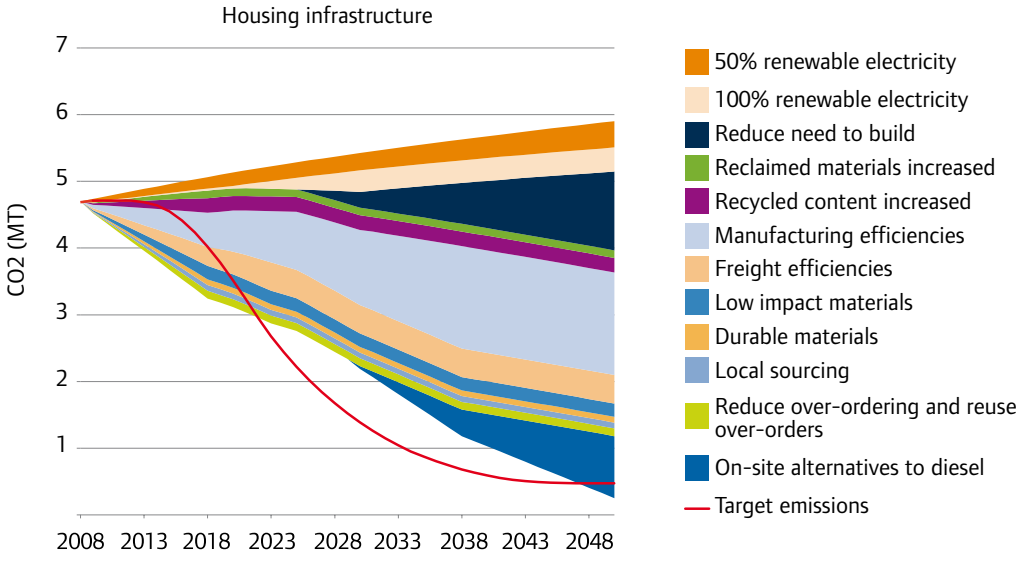


Figure 17: Measures to deliver emissions reductions from the public sector

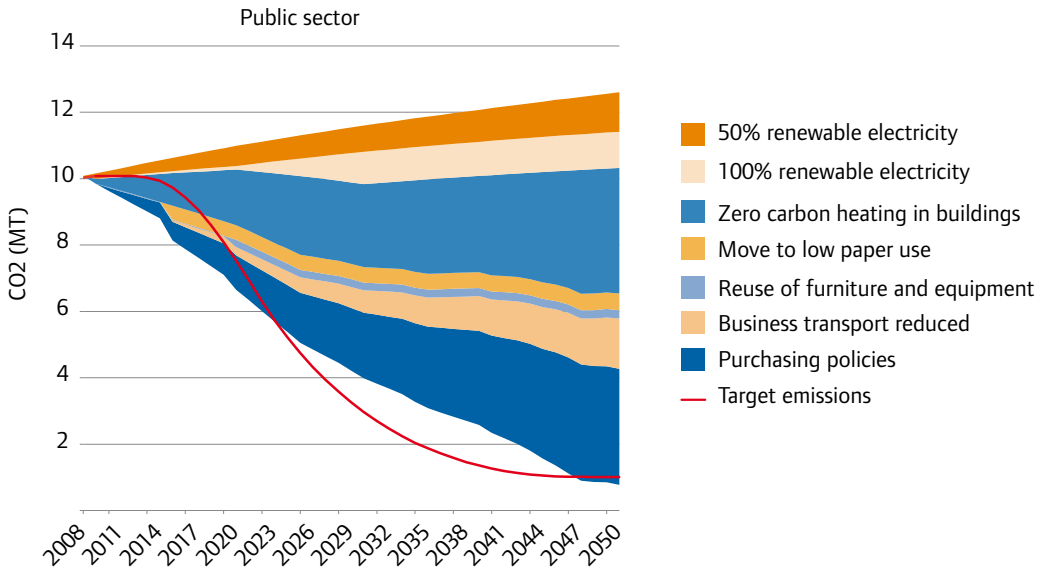


Figure 17 shows a set of CO_2 saving measures that together deliver the required CO_2 savings modelled in this study. The measures include an ambitious aim to cut CO_2 emissions from heating public buildings down to zero by 2050. Public bodies have the opportunity to lead the way in building thermal efficiencies and in large-scale procurement of biomass heating systems and CHP.

Public bodies also have the opportunity to drive change through their purchasing power. As shown below, this model projects that procurement policies could bring about 40% of the CO_2 savings in all goods and services purchased by this sector by 2050. The measures also include reducing impacts of paper consumption and of furniture and equipment purchases along with savings in business travel. The detail behind the modelling is set out in Table 13 of Appendix A.

Household energy

CO_2 emissions from domestic energy account for 22% of London's CO_2 emissions from consumption, of which 54% is for due to heating, 18% hot water, and the rest for appliances, lighting and cooking. The table below illustrates the baseline CO_2 emissions from domestic energy for London. 50% of the emissions are due to direct fuel emissions (mainly gas) and the rest are emissions related to electricity consumption within London households.

Table 5: Emissions from domestic energy consumption

	Carbon dioxide (CO_2) (Mt)	%
Electricity use on the home	9.853	50%
Direct fuel use in the home	9.904	50%
	19.756	**100%**

Figure 18: Measures to deliver emissions reductions from domestic energy

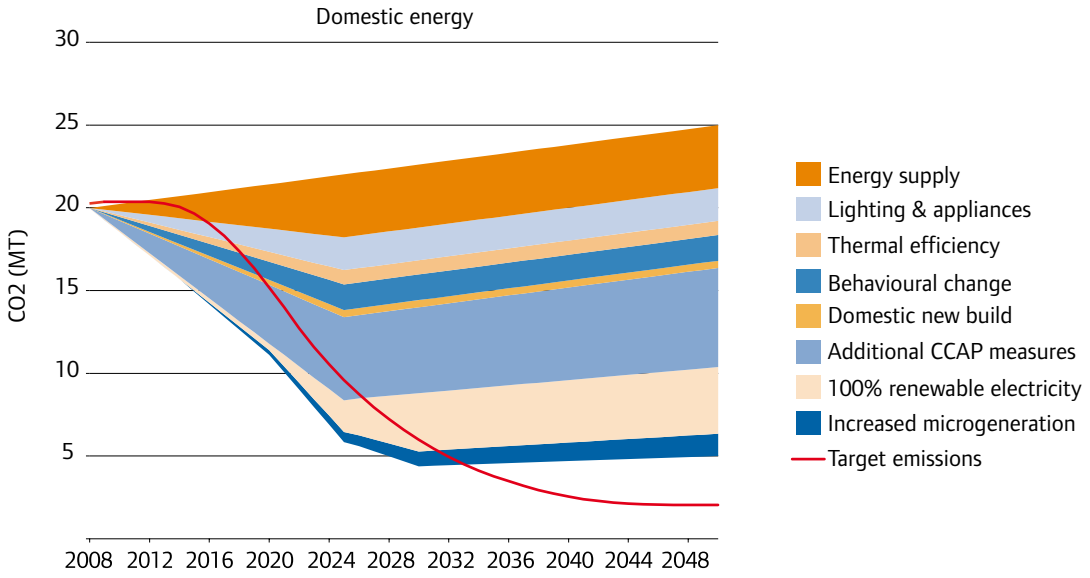


Figure 18 shows the breakdown of London Climate Change Action Plan measures delivering this 60% CO_2 saving. It also shows further measures beyond 2025 that achieve the remaining reductions needed. The detail behind the modelling is set out in Table 14 of Appendix A.

As domestic energy consumption is a key element of both consumption and production based accounts of CO_2 emissions, the household energy emissions in this model are largely the same as those modelled in the London Climate Change Action Plan. The homes being considered are the same for each model. The key difference between the two models is that this one includes the embodied emissions within the energy industry's operations - for example, the business transport of energy company employees or the energy used to heat their offices. The CCAP includes only emissions from gas and electricity use within households. Consequently, the CO_2 emissions for this sector are some 12% higher in this model than in the CCAP.

The measures modelled in this sector are predominantly taken directly from the CCAP. However, as the CCAP looks only as far as 2025, this model also considers further measures beyond 2025 up until 2050.

The Climate Change Action Plan has two scenarios. The first achieves 30% emissions savings and can be achieved through action within London. The second scenario achieves a 60% cut by 2025 but requires action at the national level and an EU level in order to be implemented. The second scenario includes an overall 50% cut in the carbon intensity of the grid. It also includes the introduction of carbon pricing and feed in tariffs. Both scenarios assume that by 2025, 25% of London's energy supply will be decentralised.

Personal transport

Personal transport accounts for 20% of London's CO_2 emissions, of which half is due to car travel and the remainder is split between air travel and public transport. The table below illustrates the baseline CO_2 emissions from personal transport. About half of the impact of car travel is due to direct fuel emissions, but the rest is due to buying and maintaining vehicles.

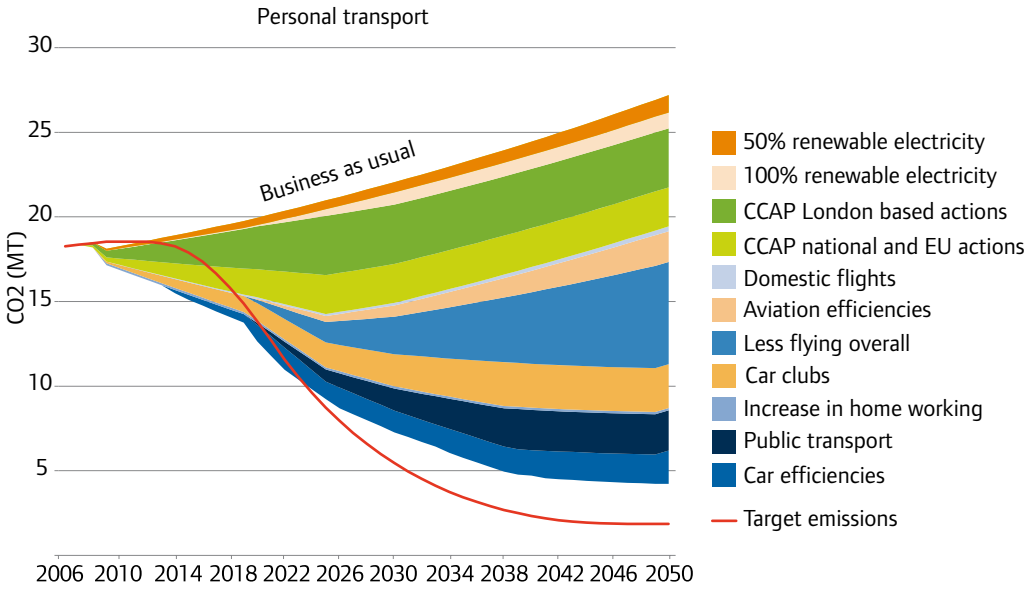
Table 6: Emissions from personal transport

	Baseline	Percentage
Purchase of vehicles	1.329	7%
Operation of personal transport equipment	3.047	17%
Private transport (car fuel)	4.413	25%
Air travel	4.970	28%
Public transport services	4.229	24%
Total	**17.989**	**100%**

In the case of transport, it is difficult to unpick the consumption-based emissions used in this model from the territorial emissions used in the London Climate Change Action Plan. The consumption emissions modelled here are for London residents and so will include transport emissions outside London when Londoners leave town. The CCAP models all transport emissions that occur within London, whether they are attributable to London residents, workers or other visitors. The other difference between the two models is that the consumption-based emissions modelled here include the embodied emissions from manufacturing vehicles, buses and trains.

Figure 19 shows a combination of measures that deliver the CO_2 savings required. They include successful delivery of the London Climate Change Action Plan, significant reductions in air travel, widespread provision of car clubs and a long-term shift towards electric cars. The detail behind the modelling is set out in Table 15 of Appendix A.

Figure 19: Measures to deliver emissions reductions from personal transport



Combined Results of Sector Analyses

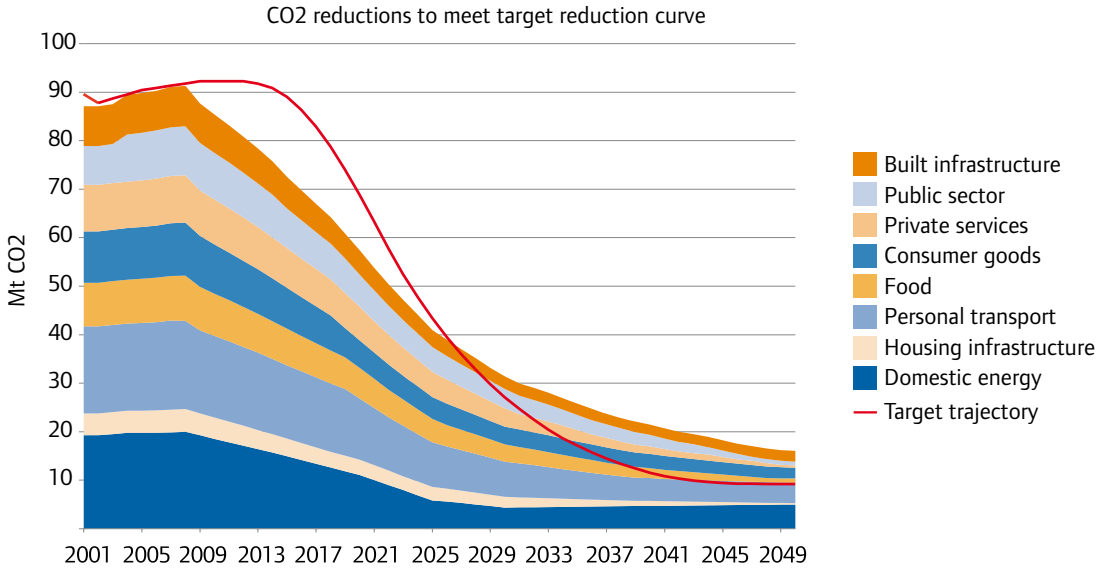
Bringing all the sector analyses together shows the total CO_2 emissions reductions that can be delivered by 2050. Each sector was reduced along approximately the same trajectory overall. The range of measures in this report has created a scenario that can achieve the carbon budget set (Figure 20).

The budget was 2.45 billion tonnes of CO_2 to be emitted between the years 2000 and 2050 and this scenario has achieved CO_2 emissions of 2.44 billion tonnes. Annual emissions from consumption have reduced from 89.5 to 16.0 million tonnes of CO_2.

Table 7: Meeting the carbon budget

	Current emissions (Mt CO_2)	Annual emissions in 2050 (Mt CO_2)
Domestic energy	19.76	5.00
Housing infrastructure	4.57	0.25
Personal transport	17.99	4.22
Food	9.05	0.90
Consumer goods	10.61	2.20
Private services	9.53	0.50
Public services	9.78	0.77
Built infrastructure	8.22	2.18
Total	**89.51**	**16.03**

Figure 20: Combined carbon emissions reductions needed to meet carbon budget



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7 Economic, social and health implications

The measures modelled in this report are wide-reaching and will involve significant change to Londoners' patterns of consumption and to London's economy. It is therefore essential to consider the wider implications of such a shift, beyond simple calculations of carbon savings, both to ensure that the measures are truly sustainable and to realise the opportunities presented by SCP to reduce poverty and inequalities and put London on a course for a more sustainable economy.

There are many possible positive links between interventions on low carbon consumption and better economic, employment, health and equalities outcomes, particularly in the context of the current economic downturn. However, such positive cycles are far from automatic and there remain challenging tensions and trade-offs. As a result, these wider considerations will need to be designed in at the outset to any measures aimed at addressing sustainable production and consumption.

This section considers both the opportunities for positive economic, social and health outcomes from the measures outlined above and the possible risks.

Economic implications

In the light of the current economic crisis and the threat of climate change there is a growing call for a fundamental re-thinking of the way in which the economy works in order to meet the major challenges of the next two decades. London's economy directly contributes to the levels of resource consumption documented within this report. As we see the current levels of resource use are unlikely to be sustainable beyond the short term. They are more likely to contribute to both irreversible climate change and a critical reduction in the planet's natural capital. Over and above the costs of not tackling climate change (as described by Lord Stern and subsequent authors[24]), any increase in demand for those very same resources (resulting from any global return to business as usual) could see London vulnerable to rising commodity prices which could, in themselves, undermine attempts to make economic recovery sustainable in all meanings of the word.

There is also a growing body of evidence which suggests that recent economic growth in some developed countries (including the UK) has not resulted in the type of improvements in quality of life that we would expect. It is now acknowledged, for example, that reliance on GDP is an inadequate measure of economic wellbeing, and serious work is ongoing to identify better ways of measuring progress[25]. Irrespective of the reasons for this we know that not everyone has benefited from London's economic growth since the mid 1990s, with significant inequalities both in terms of income and health for example.

Broadly speaking, there are currently two schools of thought regarding how a sustainable economy can be achieved. Some authors see the solutions lying in the pursuing the current economic model but with major changes including the decarbonisation of energy supply and the development of markets in low carbon products and services while others see the solution as requiring a major transformation of the economy that moves away from traditional concepts of growth.

Either way it can be argued that there is an economic imperative, more fundamental than just the creation of jobs in the green economy, to change the type and amount of goods that we consume and the value that our economy delivers.

The measures set out in this report are consistent with that imperative requiring both significant investment to establish the sustainable infrastructure we need, for renewable energy, public

transport and to dematerialise the economy; and a reduction in overall levels of consumption of carbon-intensive goods and services.

As well as putting London's economy on a more stable long-term footing, measures that contribute towards SCP and a low carbon economy can also contribute more directly to job creation and a sustainable economic recovery for London. The global market for low carbon goods and services is already worth over £3 trillion and continues to expand[26]. In the UK, the "green economy", including sectors related to SCP, is the sixth largest in the world: it employs 880,000 people and was worth £107bn in 2007/08.

London is well placed to capitalise on the economic opportunities from SCP. A recent Ernst and Young report for the London Development Agency (LDA) pointed to a combination of factors including London's scale and the concentration of strengths in financing, research and development, business services and carbon trading to suggest that the low carbon sector represents a potential investment growth of £3.7bn p/a for London to 2025[27]. The report also analysed the opportunities associated with the Mayor's carbon reduction programmes, including building retrofits, decentralised energy, energy from waste plants, and electric vehicles, and suggested that the measures could create 14,000 jobs and £600m GVA for London. Nationally, the Sustainable Development Commission has argued that a 'sustainable new deal' to promote economic recovery through measures such as upgrading existing housing stock, scaling up renewable energy supply, redesigning the national grid, promoting sustainable mobility, low-carbon investments in the public sector and developing skills for a low-carbon, sustainable economy (all measures incorporated into the modelling in this report) could generate 800,000 jobs nationally at a cost of £30bn[28]. Similarly, the UK's Low Carbon Industrial Strategy suggests that sustainable production could be worth £45bn and create 400,000 jobs in the next decade[29]. The measures modelled within this report incorporate these measures but also go further, suggesting there could be wider employment opportunities – for example from new markets based on reuse, low-carbon design, and high-tech remanufacture.

While moving to more sustainable consumption is seen as economically beneficial in the long run due to resource efficiency and the avoidance of environmental risk, there are also costs to finance the transition that need to be recognised. Stern's revised estimate for the cost of moving to a low carbon economy globally is 2% of GDP[30]. The Committee on Climate Change suggests that meeting its target for 2020 would cost 0.28% of GDP, mainly from the decarbonisation of the UK's power supply[31].

The measures modelled within this report have not been specifically costed as there is a wide range of possible mechanisms for delivery. It is likely that a number of these measures – particularly those associated with efficiency - will be cost-negative over the medium term, as indicated by McKinsey's work on carbon abatement cost curves[32]. In the longer term, the measures may also lead to costs savings in the context of carbon pricing and resource pressures on fossil fuels. However, the issue of distribution of costs and benefits remains important, and underlines the need for shared responsibility for achieving SCP.

A number of the measures here involve a reduction in current levels of consumption of carbon-intensive goods and services. In traditional economic terms, reduced consumption is often linked with reduced economic wellbeing (although as we have seen, a number of experts have challenged the links between economic growth and quality of life[33]). However, the lower levels of resource consumption suggested by the model

does not necessarily equate to lower levels of economic activity, as new business models in sustainable consumption find ways of doing more with less. This includes greater activity related to reuse, repair and refurbishment; increased resource efficiency; and models of consumption linked to services rather than ownership (see examples below).

Case studies on some new business models for sustainable consumption

- **Resource efficiency:** Making better use of materials and resources adds value to the economy and offers new business opportunities, as well as reducing waste and embodied carbon emissions. One successful example of this is the Eastex materials exchange in Suffolk. Materials exchanges are web-based information packages that enable business-to-business exchanges of surplus materials. They exploit the principle that one company's waste is another's raw material. By automatically matching organisations that have surplus materials with those seeking materials, exchanges are made and unwanted materials can be efficiently passed on or sought. This can take place as a one-off exchange or as an ongoing arrangement. Materials exchanges offer an opportunity for businesses to reduce costs associated with waste management and disposal. Costs associated with the sourcing of raw materials can also be reduced. Materials exchanges are a proven method of diverting waste away from landfill. In Suffolk it is estimated that over 1000 exchanges will take place, saving an estimated 3,000 tonnes of waste from landfill, and saving companies £300,000. At the same time the project will be looking to support up to 10 social enterprises and provide training for 60 people.[34]
- **Reuse/repair/refurbishment:** Reuse, repair and refurbishment enables economic value to be created through the re-circulation of existing goods through the economy. This limits the need for new material inputs and diverts waste from landfill, as well as creating jobs. The FRC Group, a social enterprise in Liverpool concentrating on furniture reuse, is one positive example. The Group collects unwanted furniture from approximately 40,000 homes a year, and sells it on (with a discount for low income groups) through a network of high street shops. It has a turnover of £3,500,000, and 90% of its income comes from sales.[35] Research on furniture reuse capacity by the London Community Recycling Network has found significant opportunities to scale up similar initiatives in London: out of 1.7 million potentially reusable household furniture items disposed of annually in London, only 170,000 are currently collected.[36]
- **Service-based models**: 'Product-service systems' are business models based on providing a service to meet consumer demand rather than a physical product – entailing lower material and energy requirements. It is not a new concept: early examples included launderettes or radio rentals in place of sales of washing machines or radios. However, product-service systems are attracting more interest due to the efficiency savings that they offer. Modern examples include offering online downloads instead of CDs, and car clubs, which not only reduce mileage driven but also the need for new vehicles.[37]

Social implications

The evidence base on the social implications of sustainable consumption is less well developed than for the economic implications. However there is increasing evidence linking sustainable patterns of consumption to increased social wellbeing, and suggesting that climate change and inequality can be tackled together.

On an international level, research suggests a disconnect between levels of consumption and overall well-being: beyond a certain threshold,

resource-intensive consumption no longer delivers significant well-being improvements[38]. This has led some to suggest that there is a "wellbeing dividend" that could flow from more sustainable societies and a significant potential to reduce or redistribute consumption without compromising levels of wellbeing, whether measured through life satisfaction, life expectancy or other social and health indicators.

Recent work for the London Sustainable Development Commission on inequality and sustainable development echo these findings. The research indicates that societal levels of inequality are a stronger predictor of well-being indicators such as health and happiness than overall levels of material consumption. It also finds that more equal societies are less driven by consumption, and are more willing to engage in pro-environmental behaviours than unequal societies[39].

London's current patterns of consumption are symptomatic of major inequalities both internationally and within London. As the UNDP Human Development Report notes, the average European dishwasher is responsible for more emissions than three Ethiopian citizens, and the UK (with a population of 60m) is responsible for more emissions than Egypt, Nigeria, Pakistan, and Viet Nam combined (total population 472 million)[40]. Within the UK, the social group with the highest carbon footprint from consumption emits 67% more than the group with the lowest, and this is closely related to income[41]. Such uneven patterns of consumption need to be taken into consideration when implementing measures related to SCP, to ensure that they help to reduce rather than exacerbate existing inequalities. Recent work for the Roundtable on Climate Change and Poverty in the UK concludes:

> "Unless measures to combat climate change are carefully tailored, they will hit the poorest hardest: taxing fossil fuels to reduce emissions would make it harder for people on low incomes to buy food and use transport."[42]

However, the report also lists examples of actions that could both mitigate climate change and lift people out of poverty. These include a number of the measures modelled in this report, particularly household insulation, increasing public transport, and the provision of healthy sustainable food in schools and hospitals. The increase in 'green collar jobs' expected to stem from the measures can also help reduce unemployment, poverty and inequality.

As well as understanding the different levels of consumption between different social groupings in London, it will also be vital to understand how personal consumption is linked with cultural identity. As the Sustainable Consumption Roundtable noted in their report "I will if you will",

> "Cars, houses, fashions, gifts, trophies, photographs: all these goods are called on to play vital symbolic roles in our lives. From football matches to weddings, from family holidays to dinner parties, from the work environment to social occasions, the 'evocative power' of material goods and services is used to shape our social world. Through them we negotiate status, understand our identity, interact with our family and friends, and even pursue the dreams and aspirations which give our lives meaning."[43]

Given these connections, the challenge for policy-makers is not only to make sustainable consumption aspirational for all Londoners but also to make sure that the benefits of this transformation are shared across London's diverse communities.

Health implications

The global public health community is increasingly aware of the links between public health and climate change. Of major concern are the health impacts that climate change is likely to cause. As set out in the IPCC's Fourth Assessment Report, these include: deaths from heatwaves, floods, storms, fires and droughts; malnutrition from food shortages; a spread of malaria, dengue fever and other infectious diseases; and increased problems from urban air pollution[44].

However, health practitioners are also recognising positive connections between health interventions and measures to mitigate climate change, as seen in recent reports by the World Health Organization, the Faculty of Public Health and *the Lancet*[45]. This includes strong recognition of the links between healthy lifestyles and sustainable consumption. As the Lancet argues, "a step towards low-carbon living has health benefits that will improve quality of life by challenging diseases arising from affluent high-carbon societies – obesity, diabetes, and heart disease especially – and reducing the effects of air pollution."[46]

In the context of the measures identified in this report, there are particular opportunities for positive health and climate outcomes from:

- Healthier food, including less meat and dairy consumption, which can help reduce obesity, heart disease and certain cancers
- Reduced consumption of alcohol, tobacco and sweets, which can reduce obesity and lung, liver and heart disease
- Promotion of active transport, particularly walking and cycling, which can reduce obesity and heart disease, improve physical fitness, life expectancy and mental health and help create stronger local communities
- Cleaner vehicles and traffic reduction which can improve air quality (which currently leads to 3,000 premature deaths per year in London[47]) and reduce road casualties
- Better quality, thermally efficient housing can reduce fuel poverty and the associated problems of respiratory problems, heart disease and strokes.

8 Opportunities for city-level action

The goods and services consumed by London are produced within a wide range of different contexts and locations, and supply chains are often long and complex. This means that the measures modelled in our 90% reductions scenario will require action at all levels, by the GLA family but also by international organisations, government, business, the voluntary sector, and by consumers themselves.

The global impacts of London's consumption represents not only a responsibility but also an opportunity for London residents and organisations to drive broader change, as efforts to reduce London consumption emissions will necessarily go well beyond its borders. This section looks at the opportunities that London, as a world city, can grasp in order to catalyse positive change towards more sustainable consumption, and the tools it has available for achieving this.

Policy context and existing initiatives

Issues of SCP are already being addressed by policy initiatives working at a number of levels of government; the influence that London as a city will have over the carbon content of its supply chains necessarily remains partial. Nevertheless there is still scope for London to use its influence as a world city and as a major centre for consumption and finance in order to complement actions taken at other levels and to lever in positive change.

Internationally, the Kyoto Protocol and the successor climate treaty to be negotiated in Copenhagen later this year provide the basic legal framework compelling member states to reduce emissions. While national emissions are calculated on a production rather than a consumption basis within the protocol, a strong regulatory framework will have a considerable effect in reducing emissions from the goods and services consumed by London that are produced within other developed countries.

In parallel to this, the UN's Marrakesh Process, agreed at the Johannesburg World Summit on Sustainable Development in 2002, aims to 'assist countries in their efforts to green their economies, to help corporations develop greener business models, and encourage consumers to adopt more sustainable lifestyles'.

At the European Union level, the EU Emissions Trading Scheme is a 'cap and trade' carbon pricing mechanism covering large installations such as power stations and factories. While installations within London make up less than 2% of London's emissions (calculated on a production basis), the scheme will have an impact throughout London's supply chain and a significant proportion of London's consumption emissions will be influenced by the scheme – particularly emissions related to electricity use, the goods sector and the construction industry (as cement manufacture is incorporated in the scheme).

The European Union also leads on product standards. In 2008, the EU agreed a SCP and Sustainable Industrial Strategy action plan, covering policy levers such as eco-labelling and minimum standards for products (including 'eco-design' standards taking a whole life approach, and energy-using products directives addressing energy-in-use). EU waste directives (among other policy areas) also affect SCP in London.

Much of the policy context for SCP is set nationally. Government policy in areas such as energy and transport will have a strong bearing on patterns of production and consumption within the UK, and carbon pricing instruments such as the Carbon Reduction Commitment and the Climate Change Levy cover sectors of the economy not already included in the EUETS. SCP

has also been identified as one of four priority areas in Securing the Future, the government's sustainable development strategy. Activities specifically related to SCP include product roadmapping for 10 key product areas, promotion and advisory work for consumers through the Act on CO_2 campaign and the Energy Saving Trust, advice to business through the Carbon Trust, and support for technological development and low-carbon innovation through Technology Strategy Boards and the Market Transformation Programme.

At the local level, local authorities are engaged in a range of initiatives that relate to sustainable consumption. This is particularly in relation to waste, where councils have service delivery responsibilities, but is also evident in other areas such as domestic energy use and local travel.

Governmental activity is complemented by activities involving a range of non-state actors, including voluntary groups and businesses. Organisations such as Global Action Plan have developed innovative models of engaging with communities to promote sustainable lifestyles, while companies such as B&Q have worked with BioRegional to reduce their own emissions and to select, develop and promote products which help their customers to achieve sustainable living.

As noted in the sectoral analyses above, a number of facets of SCP are already being addressed within London, particularly where there is crossover with production emissions. This is set out in detail in London's Climate Change Action Plan, which proposes interventions on the energy use of domestic and commercial buildings, new build, energy supply and transport. As demonstrated in the modelling, many of the activities designed to tackle London's production-based emissions will make a substantial contribution to reducing London's emissions from consumption.

Opportunities for London

In this context, London has the opportunity to catalyse further change, complementing rather than duplicating existing activities. The LSDC report *Sustainable Consumption and Production in London* identifies a number of particular characteristics, and by extension opportunities for London:

Purchasing power

London is a large consumer of goods and services

Manufacturing

London's role in manufacturing has declined and London is presently a major provider of services rather than goods

Financial sector

London's role as a world financial centre has implications for SCP in terms of socially responsible investment and business development outside the capital

Research and development

London has a strong knowledge economy and is a centre for research and development providing potential for innovation in sustainable production.

Equity and ethics

London's diversity and the polarisation between rich and poor means that issues of ethics and social equity should be of greater importance in considering SCP within London.

London's reach

The economic and geographic scale and reach of London means it has a responsibility to consider the implications of decisions and activities on its hinterland as well as further afield including less developed countries.

Given these particular characteristics of London and the policy context, there are a number of

tools for London as a city to drive forward positive change. These include:

- Purchasing power and procurement
- Programmes
- Planning policy
- Piloting and innovation
- Partnership working
- Promotion of sustainable lifestyles

Purchasing power and procurement

Why is this important?

Representing 1% of the global economy[48], London has an enormous influence on markets and supply chains, both in the UK and internationally.

Public expenditure in London in 2006/7 totalled £79.8 billion[49]. The combined procurement expenditure of London Boroughs, the City of London and the GLA group is around £14bn per year[50].

What are the opportunities?

The Joining the Gaps in Sustainable Procurement project provides a significant opportunity to transform markets and supply chains through Green Public Procurement. Bringing together the GLA Group, London Councils and the City of London, this project could begin to redirect billions of pounds of expenditure each year.

Wider public sector procurement, and continued engagement with the private sector through initiatives such as the Mayor's Green Procurement Code, provide further opportunities to embed sustainable purchasing policies.

What does it look like?

The new NHS carbon reduction strategy 'Saving Carbon, Improving Health' provides a good example of how public sector bodies can use procurement to reduce their CO_2 emissions[51]. A full carbon footprint analysis was carried out for NHS England, and 60% of emissions were found to be attributable to procurement. Actions proposed in the strategy to reduce emissions from procurement include:

- Reducing over-ordering, particularly of pharmaceuticals
- Requiring all suppliers to disclose their approach to sustainable development and to carbon management, and working with them to procure lower carbon products
- Procuring and producing sustainable, healthy and low carbon food for patients, visitors and staff
- Considering lifecycle carbon costs in procurement decisions rather than just the cheapest price.

Programmes

Why are they important?

The GLA group and London Boroughs provide a number of services and initiatives that shape residents' consumption patterns. These include: public transport provision, and the promotion of walking and cycling by Transport for London; London Borough and LDA waste and recycling programmes; and energy efficiency and generation initiatives from the GLA and London Boroughs.

What are the opportunities?

There are extensive opportunities to deliver measures identified in this report either through new programmes at the borough or London level, or by extending or reshaping existing programmes and services. In some cases, there may be opportunities for sustainable consumption measures to be delivered as co-benefits of wider programmes. For example:

- Reducing the carbon cost of London's food economy
- Delivery of the carbon reduction elements of the London Freight Plan
- Developing networks for furniture reuse

- Considering infrastructure and construction impacts as part of energy efficiency, decentralised energy and regeneration programmes

What would they look like?

Co-benefits from existing programmes are already being considered in London, for example:

- Olympic delivery organisations have committed to make the Olympics Park a 'blueprint for sustainable living' in the legacy phase.
- The GLA's Low Carbon Zones programme, which will showcase low-carbon energy measures in the built environment in 10 London neighbourhoods, will also seek to promote wider sustainability dimensions including food growing, waste reduction and sustainable transport.

Planning policy

Why is this important?

Planning policy and controls in the GLA group and London Boroughs have an enormous impact on the quantity and character of development in London. Planning policy shapes the anticipated provision of new housing, commercial and industrial premises, and the infrastructure they require. It can influence the construction standards, including materials, buildings, energy and water infrastructure, and considerations for transport, food and waste. Planning also determines the density of new development, which in turn shapes travel and energy demands and material use.

What are the opportunities?

The London Plan provides a strategic planning overview, which could seize a huge opportunity to prioritise existing infrastructure, and drive high-quality refurbishment before new built infrastructure and construction works. Our modelling shows that this could save 2.55m tonnes CO_2 per year, equivalent to the total emissions from the residents of the London Borough of Harrow.

Intelligent planning policies including GLA guidance and London Borough's Local Development Frameworks could also catalyse local change. For example, our modelling suggests that strengthened standards on sustainable materials – typically included in supplementary documents on Sustainable Design and Construction[52] – could save 5.07m t CO_2 per year, equivalent to the total emissions from the residents of the London Boroughs of Lewisham and Sutton.

What would it look like?

The Planning and Climate Change supplement to Planning Policy Statement 1 requires that climate change is properly considered, and the London Plan seeks to reduce carbon emissions from the built environment by requiring on-site renewable energy and connection to Combined Heat and Power networks. However, to date planning policies have not addressed SCP in an integrated manner, for example through taking full account of the embodied carbon from materials and the consumption patterns of residents. The BedZED development in Sutton, built in 2002 and still the UK's largest sustainable community, is a good example of how planning policy can address built infrastructure, help London reduce its energy consumption and apply choice editing techniques to promote sustainable lifestyles. The development was based upon a strategy that encompassed the housing infrastructure, domestic energy use, transport, food and consumer goods. The average resident's CO_2 emissions arising from consumption are 11% lower than the local average, whilst a keen resident is able to reduce their emissions by 46%[53].

Piloting & innovation

Why is this important?

Delivering a 90% reduction in CO_2 emissions from consumption by 2050 while achieving positive

social, economic and health outcomes for London will require significant innovation in new technologies and new business models. Due to the concentration of consumers and producers within London – and London's position as a major centre for research and development, business services and investment finance – London is strongly situated to develop and capitalise on new business opportunities and models for sustainability.

What are the opportunities?

London stands to benefit from many opportunities for innovative business models around resource efficiency and sustainable production, which could form a core element of London's economic recovery. Some of the measures modelling in this report currently lack businesses to deliver them.

For example, waste services in London currently reflect the prioritisation of tonnage in recycling and landfill diversion, rather than maximising the carbon benefits. With the right assistance, businesses in London could develop the commercial and industrial systems to enable the reuse of over-ordered and waste construction materials; or to take segregated waste from London, recycle it locally, and sell it back to London's businesses and public sector organisations.

What would it look like?

Pilot projects from the public, private and third sector have provided plenty of positive examples, such as:

- Local paper loops in London have been promoted by BioRegional. They began by promoting office paper recycling services that used a local mill in Kent, and encouraged procurement officers to buy the paper back from the mill. This reduces the ecological footprint of office paper by 93% compared to virgin imported paper[54]. Spotting a gap in the market, BioRegional then established The Laundry, a social enterprise which provides cheap, fun and easy kerbside recycling for SMEs in London who previously had nowhere to turn. Whilst London remains a long way from making local paper loop recycling the norm, this initiative shows how public-private and public-third sector pilots can kick-start sustainable consumption.
- In 2007 the LDA developed a plot of land in Dagenham, east London, as a 'Sustainable Industries Park' and supported Closed Loop Recycling to establish the first food-grade plastics recycling plant in the UK. The plant fills an important gap in the waste cycle and will recycle 35,000 tonnes of mixed plastics every year that previously would have been either exported for recycling or landfilled. It also creates jobs and economic opportunities within a regeneration area. There are proposals emerging for a wider 'Green Enterprise District' in east London that will enable more innovations for environmental technologies to be supported[55].

Partnership

Why is this important?

As a leading global economy, London is a major centre of consumption *and* production, providing a transformative opportunity to forge partnerships that can reduce the carbon impact of goods and services we provide and produce, use and consume.

What is the opportunity?

The public sector could work with business and the voluntary sector to identity opportunities to take these measures forward, and create sectoral roadmaps taking plans from the measures modelled in this report.

Areas of consumption identified in this report where there is both a significant proportion of London's carbon footprint and a concentration of major industry players in London include:

- The catering sector (40% of food sector carbon dioxide emissions);
- Jewellery and watches retailers (9% consumer goods sector CO_2);
- Insurance (11% of private services sector CO_2); and
- Financial services (4% of private services sector CO_2).

Businesses and trade bodies in these sectors could adopt Defra's 'product roadmapping' approach:

- identify the impacts that occur across each product's life cycle
- define a vision for each product to help address its impacts and make it more sustainable
- set out a course of action - comprising short, medium and long-term measures aimed at the life cycle stages generating the highest impacts - to achieve that vision.

What would it look like?

There are several positive examples of this approach already occurring within London:

- Music industry stakeholders came together with the charity Julie's Bicycle and the GLA to produce the 'Green Music' programme for London. The report estimates that the music industry in London is responsible for 465,300 tonnes of CO_2 per year, including not only 'direct' emissions from buildings and transport but also 'indirect' emissions associated with packaging and merchandise. The programme presents an action plan aimed at reducing this by 60% by 2025, and aims to help the London music industry not only to take action on climate change but also to save money, stay ahead of regulation and develop comparative advantage.
- Similarly, the Green Theatre Programme for London (published in 2008) is the result of collaboration between the GLA, Arts Council England, and theatres including the Royal Court, the National Theatre and Arcola Theatre. The report estimates theatres in London are responsible for 50,000 tonnes of CO_2 per year, and sets out measures that could reduce this by 60% by 2025[56].
- The LDA is currently convening the 'Better Buildings Partnership', which brings together the largest commercial and public property owners in London to encourage widespread sustainable building retrofits and to seek ways of overcoming the 'split incentive' between building owners and occupiers that currently discourages energy efficiency measures being implemented.

Promotion of sustainable lifestyles

Why is this important?

Ultimately, it will be individual Londoners who make the changes to their consumption patterns that this report has modelled. As set out in the Sustainable Consumption Roundtable's 'I Will If You Will' report, action by public bodies, businesses and the voluntary sector can make it easier for people to choose sustainable lifestyles.

What are the opportunities?

London can promote sustainable lifestyles with three approaches:

Leadership: Public sector bodies, businesses and the voluntary sector can inspire broader change by demonstrating leadership and reducing their own emissions. By calculating and committing to reduce its own consumption-related emissions, the GLA and other bodies can help convince others to do the same.

Advice: It is not always clear to consumers how to make sustainable consumption choices, and public bodies can play a role in providing trusted information and promoting positive options.

The GLA currently supports the London Energy Saving Trust Advice Centre which provides guidance on domestic carbon emissions and home retrofits. Transport for London also leads a programme of personalised travel planning to help Londoners make sustainable transport choices. There may be scope to broaden advisory service provision to take account of wider consumption-related emissions.

Engagement: There is potential here for both incorporating issues of sustainable consumption into community level initiatives (e.g. Low Carbon Zones) and also for sparking a broader London-level debate on how London as a city can take responsibility for the impacts of the resources that it consumes. This report may be seen as a contribution to the opening up of that debate.

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9 Conclusions

This study sets out an evidence base for ways in which London could achieve a 90% reduction in carbon emissions needed by 2050, using the more challenging, and higher figure for consumption based emissions as a baseline.

The analysis highlights where our impacts arise and outlines a set of proposed measures that could reduce our impacts to a sustainable level. By modelling emission reductions, this report provides the reader with a clear picture of how needed reductions in consumption emissions could be achieved.

Ultimately, the SCP approach taken by this report could, if taken up by those with the power to make a difference, unleash innovation and creativity which really would make London an exemplary sustainable world city.

If government, businesses and London organisations applied the SCP thinking to their daily activities and responsibilities, then together we could;

- harness the purchasing power of London's people and organisations to establish consumption patterns that achieve positive economic, social and environmental outcomes in London and beyond
- develop new ways to produce goods and deliver services in London towards more resource efficient and socially beneficial processes
- create a more vibrant economy, future proofed against resource constraints.

It is also important to acknowledge that the measures needed to reduce emissions cannot be achieved by action within London alone. The supply chains and policy contexts influencing consumption in London are global in scope, therefore responsibility for bringing about the measures has to be shared between governments at all levels, businesses and consumers.

There can be little doubt that achieving major reductions in carbon emissions will be challenging. However, this report demonstrates that these reductions will be possible and can bring with them wider economic, social and health benefits for London, and indeed lead to positive gains well beyond its borders.

Appendix A: Detailed modelling

Table 8: CO_2 Reduction Measures Modelled for Food

Measure	Description	Annual Saving by 2050 ($MtCO_2$)	Assumptions
Renewable Electricity Strategy	This measure represents delivery of current policy. The BERR Renewable Energy Strategy successfully delivers 30% renewable electricity grid mix by 2020. The Climate Change Act is assumed to necessitate a 50% renewable electricity grid mix by 2050.	1.17	30% renewable electricity by 2020, 50% by 2050.
100% renewable electricity	This measure represents delivery of the Climate Change Committee recommendations on grid decarbonisation for a 90% reduction scenario, delivering a 95% renewable grid mix by 2030 and 100% by 2050. This measure relies on successful development of balancing technologies with sufficient capacity.	1.07	95% renewable grid mix by 2030, 100% renewable by 2050.
Reduced food waste	One third of all bought food in the UK is thrown away. By reducing food waste, CO_2 savings are made both through reduced consumption and reduced waste processing activities. WRAP has launched the Love Food Hate Waste campaign[57] which calculated that 15 million tonnes of greenhouse gases could be saved by reducing food waste throughout the UK. This measure assumes successful implementation of Love Food Hate Waste across the UK by 2050.	1.45	16% CO_2 reduction[58]
Lower meat and dairy consumption	Meat and dairy accounts for 37% of food CO_2 and 51% of greenhouse gas emissions. FCRN identifies reduction of these as a high priority. It suggests that it is possible to halve meat consumption and reduce dairy by two thirds by 2050 through: • Shift by manufacturers and retailers towards meals with lower meat and dairy content • Carbon pricing • Education and behaviour change. This would result in a saving of 1.8Mt CO_2 of which 0.5Mt is offset by substituted alternative foods.[59]	1.63	Meat consumption halved and dairy consumption cut by 2/3rds by 2050

Measure	Description	Annual Saving by 2050 ($MtCO_2$)	Assumptions
Farm emissions improvements	The FCRN report suggests that a 40% reduction in emissions on farms would be possible by 2050. This is ambitious and would include: • decarbonising the production system through combined heat and power, anaerobic digestion and biomass • optimising the application of fertilisers and increasing the use of renewable fertilisers such as manure & legumes • improved efficiency of crop and livestock breeding programmes, whilst still considering animal welfare[60] This model adopts a stretching measure which assumes a 40% saving in the farming sector by 2050.	2.42	40% reduction in emissions from farms
Post farm gate improvements	The FCRN report recommends that the following measures could achieve a 70% reduction post farm gate by 2050: • improvements in refrigeration technology and management, • on-site renewables use by manufacturers • improved freight efficiency and modal shifts e.g. air to sea or road to rail • retailer efficiency improvements e.g. energy efficiency in stores, reduced waste, storage and delivery efficiencies • efficiency improvements in the catering industry	2.42	70% reduction in emissions from post farm distribution
Consumption of sweets and alcohol	The savings from behaviour changes to avoid "luxury" foodstuffs (sweets and alcohol) were modelled. Savings from this behaviour change are relatively small. It could be argued that these changes would lead to additional savings due to the dietary improvements and savings in healthcare.	0.34	Alcohol and sweet consumption halved

Table 9: CO_2 Reduction Measures Modelled for Consumer Goods

Measure	Description	Annual Saving by 2050 ($MtCO_2$)	Assumptions
Renewable Electricity Strategy	As above.	1.19	30% renewable electricity by 2020, 50% by 2050.
100% renewable electricity	As above.	1.10	95% renewable grid mix by 2030, 100% renewable by 2050.
Waste Strategy 2007	This measure represents delivery of current policy. The Waste Strategy 2007 contains targets for 50% recycling and composting of household waste and 75% recovery of municipal waste by 2020. It includes a target to reduce CO_2 emissions by 9.3 million tonnes by 2020.	1.10	50% household recycling and composting 75% municipal waste recovery Waste Strategy 2007 delivers target 9.3Mt CO_2 saving
Ambitious waste strategy	This measure represents delivery of a more ambitious strategy within the Waste Strategy 2007. The higher targets focus on waste prevention, improvements in commercial waste management and financial incentives schemes for domestic waste reduction. The strategy includes a target to reduce residual waste by 50% (i.e. waste that cannot be reused or recycled).	0.90	Waste Strategy targets exceeded and waste prevention measures implemented. Residual waste reduced by 50%
Freight efficiencies	Road haulage distribution within the UK accounts for 6% of the retail sector's CO_2 emissions. (This figure excludes international haulage emissions.) The London Freight Plan has a series of steps estimated to make a 45% saving in emissions. The steps include a mode shift from road and air to rail and sea, more efficient operation of lorries, eco-driving skills and low-carbon fuels.	0.37	London Freight Plan is successfully implemented both in London and also across the UK 45% saving on domestic freight emissions
Electronics consumption reduced	Electronic goods account for 14% of CO_2 emissions from consumer goods. This measure assumes a 50% CO_2 saving for this product group through reduced consumption and through industry efficiencies. High turnover of electronics goods is driven by constant innovation and new products. An industry shift towards product design that allows for upgrades and refurbishment rather than new purchases will provide more jobs and more CO_2 savings. If products can last twice as long, then embodied emissions can potentially be halved.	0.61	Consumption of electronic goods is cut by 50%

Measure	Description	Annual Saving by 2050 ($MtCO_2$)	Assumptions
Local paper recycling loops	Paper and card account for 5% of CO_2 emissions from consumer goods. Local paper loops are a closed loop system of waste paper collection, recycling and remanufacture into new paper, all on a local basis. London already has a local paper loop system in place with capacity to expand or be replicated. Local paper loops can give CO_2 savings of up to 80%[61].	0.27	Half of all paper consumption shifts from virgin pulp to local paper loop production
Longer lasting clothes	Clothing represents 8% of CO_2 emissions from consumer goods. This measure assumes a 25% CO_2 saving through longer lasting clothes and through greater reuse. The textiles mass balance report[62] shows that consumers in the UK send one eighth of their discarded clothes for re-use through charity shops and the rest is disposed of, suggesting considerable potential for greater reuse.	0.74	25% reduction in CO_2 emissions.
Durable floor coverings	The textiles mass balance[63] suggests that a doubling in the life of carpets could save 55% of the CO_2 emissions. This can be achieved through new materials and improvements to quality.	0.58	55% cut in emissions Floor coverings lifespan is doubled
Household goods recycling	A reduction in the impact of household goods such as furniture, white appliances, textiles could be achieved with a significant move towards more reuse and refurbishment of these goods. Investment in reuse schemes and provision of space for reuse activities will help to achieve this measure.	0.93	A 25% reduction in consumption of household goods such as furniture, white appliances, and textiles
Jewellery consumption reduced	Jewellery and personal effects account for 19% of the goods CO_2 emissions of the average Londoner. This model includes a 50% reduction in emissions from jewellery through changing purchasing patterns including greater reuse and less consumption, together with efficiencies in the production of jewellery through all stages of the industry, including mining, processing and distribution.	0.46	50% reduction in the consumption impacts of jewellery

Measure	Description	Annual Saving by 2050 ($MtCO_2$)	Assumptions
Reduction in smoking	Tobacco products account for 1% of the goods CO_2 footprint. Current levels of smoking are at 17% in the general population. This measure represents delivery of the Smoke Free Coalition targets to reduce smoking to 10% by 2020 and 5% by 2030. The model further assumes no smoking by 2050.	0.59	Smoking reduced from 17% to 10% by 2020 and 5% by 2030. No smoking by 2050.
Overall industry efficiencies	This measure assumes a blanket improvement across all manufacturers of goods around the world supplying London consumers. Illustratively, the chemicals industry has targeted reductions of 18.3% from 1998 to 2010 through good housekeeping, additional waste heat recovery, improvements to steam systems, better energy management leading to correctly sized motors and drive systems, optimising pipe systems and other improvements[64]. In addition to onsite energy efficiencies, businesses can reduce their emissions further by considering material choices with lower embodied CO_2 e.g. WRAP's work with Indesit on recycled plastic in washing machines[65]. Procurement policies such as the Mayor's Green Procurement Code can be used to favour reduced upstream emissions.	2.53	18% efficiencies in production of goods

Table 10: CO_2 Reduction Measures for Private Services

Measure	Description	Annual Saving by 2050 ($MtCO_2$)	Assumptions
Renewable electricity strategy	As above.	1.29	30% renewable electricity by 2020, 50% by 2050.
100% renewable electricity	As above.	1.19	95% renewable grid mix by 2030, 100% renewable by 2050.
Reduced consumption of water	This measure represents water savings in homes. These water savings in turn allow the water industry to reduce its energy requirements for pumping and treating water (currently 1% of the UK's direct CO_2 emissions). Water wastage through pipe leaks is a particular problem in London due to the high density of buildings and the age of the water pipes, and there is considerable scope for reducing water use through reducing leakage. Common, affordable domestic water efficiency measures such as low flush toilets, spray taps and rainwater butts have been shown to reduce water consumption by up to 40%. Water metering reduces water use by providing a direct link between consumption and cost. About 20% of households in London are currently metered and the Environment Agency has aspirations for this figure to climb to 75% by 2025. Increased availability of affordable water efficient appliances will help reduce demand further.	0.16	Domestic water consumption in London is reduced from 170 litres to 100 litres per person per day by 2050.
Zero carbon heating in commercial buildings	Approximately 20% of the total carbon footprint of this sector could come from on site heating. A combination of thermal energy efficiency measures, district heating systems supplied by CHP and changes to the fuel supply could enable significant savings on these emissions. Medium to large scale businesses have the capacity to procure zero carbon heating systems more easily than individual householders. This is acknowledged as an ambitious and stretching measure. Following in the footsteps of a similar measure for public sector buildings, this measure aims for 30% of all private service premises to run on zero carbon heating by 2025 and 100% by 2050.	2.95	Assumes that 20% of business services CO_2 impact is due space heating from gas Assumes that 30% of all private services premises run on zero carbon heating by 2025 and 100% by 2050

Measure	Description	Annual Saving by 2050 ($MtCO_2$)	Assumptions
Paper saving and recycling loops	The model uses REAP and Bottomline3 software (BL3)[66] to estimate that office paper accounts for around 5% of CO_2 emissions from the private services sector. Simple changes can enable offices to cut their paper consumption by half through easy measures such as double sided printing, doubling up pages and behavioural changes to reduce the need for printing. Paper saving measures save money too. Local paper loops are a closed loop system of waste paper collection, recycling and remanufacture into new paper, all on a local basis. London already has a local paper loop system in place with capacity to expand or be replicated. Local paper loops can give CO_2 savings of up to 80%[67].	0.49	Assumes 5% of business services CO_2 emissions are due to paper consumption Half of all paper consumption shifts from virgin pulp to local paper loop production resulting in a 40% CO_2 saving
Furniture and equipment reuse	The model uses REAP and BL3[68] to estimate that furniture and equipment account for around 10% of CO_2 emissions from the private services sector. This measure represents a reduction in this area through greater reuse and through lowering turnover of these items. There are numerous reuse initiatives across London making use of items disposed of whilst still in very good condition. The measure assumes significant investment in the reuse sector. Each PC has around 1 tonne of embodied CO_2[69]. IT reuse has significant potential to be increased. WEEE legislation is leading to increased recycling, but this measure assumes growth and investment in the reuse and refurbishment of IT equipment.	0.31	Assumes 10% of business services CO_2 emissions are due to furniture and office equipment. Assumes 25% savings can be made through reuse and lower turnover.

Measure	Description	Annual Saving by 2050 ($MtCO_2$)	Assumptions
Business travel	Business travel, (covering all public transport, company cars, and air travel) varies widely from business to business. However, BL3 data would indicate a range from 8% to 30% of all carbon emissions for the examples identified. This measure allows for policies that reduce the need for travel, improve fleet efficiencies and eco-driving training for employees. In the longer term, a shift towards alternative low carbon or zero carbon vehicle fuels is assumed. (See the transport section for more details).	0.98	Assumes 10% of business services impact is due to business travel. 80% of this is due to air travel, and 20% land based travel. 80% reduction achieved through 50% reduction in air travel and aviation efficiencies. Reduction in car use and eventual move to low carbon cars.
Resource efficiencies, procurement policies and alternative fuels	Within this sector, there is very little data available on the breakdown of indirect CO_2 emissions. This makes it difficult to be specific about reductions. This measure represents the reduction that is necessary rather than what is known to be possible. Examples of activities that the service sector could use to contribute towards this reduction include: • Improved waste management practices alongside a focus on reduce and reuse • Procurement policies have enormous potential to influence supply chains in some parts of this sector, e.g. the insurance industry is the largest purchaser of carpets. Procurement of lower impact, more durable carpets would drive change across the whole carpet manufacturing industry. • Impacts of improving freight systems will also reduce the services sector emissions.	4.41	Assumes a combination of all these factors would be able to deliver a 35% cut in emissions by 2040 if this sector is to stay within its budget.

Table 11: CO_2 Reduction Measures Modelled for Built Infrastructure

Measure	Description	Annual Saving by 2050 ($MtCO_2$)	Assumptions
Renewable electricity strategy	As above.	0.71	30% renewable electricity by 2020, 50% by 2050.
100% renewable electricity	As above.	0.65	95% renewable grid mix by 2030, 100% renewable by 2050. Assuming the successful development of balancing technologies with sufficient capacity to allow this.
Strategic planning to reduce need for new infrastructure	This measure represents a reduction in construction activity but an increase in refurbishment activity by making better use of existing buildings and infrastructure. According to the Urban Task Force report there are 4,500 hectares of land in the UK occupied by vacant commercial buildings[70]. These should be refurbished and utilised wherever possible. A reduction in the consumption of certain goods can lead to a reduced need for factories and new retail premises, although maintenance of existing premises should continue. This measure assumes no further expansion of airports or motorways but maintenance continues of existing facilities in these categories continues.	2.32	5% reduction across all sectors 40% reduction in water in line with reduced consumption 50% reduction in investment in roads, airports, valuables, retail and motor vehicles. Investment in rail and electricity infrastructure is doubled Investment in gas is partially transferred to allow for investment in installation of district heating systems. Overall, 20% reduction by 2030.
Low impact materials	The BedZED Construction Materials Report[71] showed how by choosing low impact materials and low impact components carefully, embodied CO_2 emissions can be reduced significantly. Savings can generally be made through choosing to use less concrete, less cement, less uPVC and more timber. These savings can be achieved not only by simple choice of materials but also by lean, efficient design (e.g. pre-stressed concrete uses less concrete to do the same job), or prefabricated components can result in less wastage.	0.78	10% saving of embodied CO_2 through low impact material choices by 2020.

Measure	Description	Annual Saving by 2050 ($MtCO_2$)	Assumptions
Reduce over-ordering and reuse over-ordered material	3% of the construction industry's resource consumption is due to over-ordering of materials[72]. This measure represents a shift to best practice in efficient materials procurement and also greater reuse of over ordered materials through building materials reuse schemes like Habitat Restores [73] who run a chain of hundreds of retail outlets across north America or ReIY, the UK fledgling equivalent[74].	0.20	Over-ordering reduced by 14%. 75% of the over-ordered materials reused or reclaimed elsewhere Overall CO_2 saving of 2.3% by 2020.
Local sourcing	Haulage of construction materials within the UK accounts for some 20% of the embodied impact of construction. Experience on BedZED showed that by simply choosing the most local supplier for standard products, haulage of materials can be reduced significantly compared with national average haulage distances recorded by the Building Research Establishment. This can be a simple, cost free measure.	0.15	Embodied CO_2 of all construction materials reduced by 2% through local sourcing by 2020.
Manufacturing efficiencies	This measure represents a 20% resource efficiency improvement amongst manufacturers of construction materials between now and 2050. The environmental impact of all building materials depends on the processes used to extract, process and manufacture them. Resource efficiency measures can save the company money as well as reduce CO_2 emissions.	1.32	Manufacturers of building products improve efficiency by 20%.
Recycled content in construction materials	Increasing the recycled content of building materials achieves two things. It diverts waste from landfill, generating a market for materials that would otherwise cost money to dispose of. It also displaces the need for new materials. The degree to which increasing recycled content actually reduces embodied CO_2 emissions is different for each product and for each source of recycled material. Using data from WRAP and BRE, Bioregional have estimated that an ambitious but technically possible increase in recycled materials would give a CO_2 saving of 9.6%.[75]	0.50	Increased recycled content results in CO_2 saving of 9.6% by 2020

Measure	Description	Annual Saving by 2050 ($MtCO_2$)	Assumptions
Increase in reclamation	The re-use of waste building materials in their existing state without down-grading and reprocessing is the best environmental option for supplying construction projects. There is a massive untapped resource of materials arising from demolition sites or being dismantled from temporary works. This measure is ambitious and relies on significant investment in infrastructure and storage space for reuse activities. It relies on considerable business development in the reuse sector and a culture change in the demolition process and in the materials procurement process. The measure is based on the following levels of reclaimed materials: • Concrete blocks and paving to be 5% reclaimed • Slate products to be 25% reclaimed • Bricks to be 15% reclaimed • Structural steel to be 20% reclaimed • Metal products to be 15% reclaimed • Timber products to be 15% reclaimed	0.45	Increased reuse results in CO_2 savings of 5.5%[76] by 2020.
Durable materials	Repairs and maintenance can be reduced through use of durable components. For example aluminium is a highly durable material with a long lifespan of 60 years and is therefore an appropriate solution in some cases, despite its high embodied energy. Innovation in new more durable materials and components will also play a part.	0.15	Assume durable material choices result in CO_2 saving of 2% by 2020
Freight improvements	20% of construction emissions are due to freight. This measure represents a set of freight improvements based around the London Freight Plan and other best practice. The measures are applied both within London and across the UK. It assumes higher lorry efficiencies, eco-driving skills, some mode shift from road to rail or water and an eventual move to low carbon fuels.	0.48	Assumes that 20% of built infrastructure emissions are due to freight. Freight efficiency measures result in a 45% CO_2 saving by 2025.

Measure	Description	Annual Saving by 2050 ($MtCO_2$)	Assumptions
Alternatives to diesel	Diesel powered plant and generators on construction sites account for 10% of the CO_2 emissions in this sector[77]. In the long term there are some promising diesel alternatives that are either zero-carbon or near zero-carbon.	0.74	Diesel powered plant accounts for 10% of built infrastructure emissions Diesel alternatives become available from 2025 By 2050, diesel alternatives have resulted in a 70% CO_2 saving on construction sites

Table 12: CO_2 Reduction Measures Modelled for Housing Infrastructure

Measure	Description	Annual Saving by 2050 ($MtCO_2$)	Assumptions
Renewable Electricity Strategy	As above.	0.39	30% renewable electricity by 2020, 50% by 2050.
100% renewable electricity	As above.	0.36	95% renewable grid mix by 2030, 100% renewable by 2050. Assuming the successful development of balancing technologies with sufficient capacity to allow this.
Reclaimed materials increased	See similar measure in built infrastructure section above. The measure is based on the following levels of reclaimed materials: • Concrete blocks and paving to be 5% reclaimed • Slate products to be 25% reclaimed • Bricks to be 15% reclaimed • Structural steel to be 20% reclaimed • Metal products to be 15% reclaimed • Timber products to be 15% reclaimed	0.11	Increased reuse results in CO_2 savings of 5.5%[78] by 2020.

Measure	Description	Annual Saving by 2050 ($MtCO_2$)	Assumptions
Strategic planning to reduce need for new infrastructure	Due to housing demand and the current population shift towards London, this measure makes no reductions in house building activities until after 2025. However, between now and 2025, it is assumed that there will be a shift from new build towards mass retrofit. It assumes that all existing empty homes within London will be restored and utilised. Refurbishment projects are incentivised through removal of VAT, favourable planning policies and other financial incentives. Retrofit schemes to existing occupied homes are rolled out across London and the UK. Post 2025, it is assumed that the trend for migration towards London will have stopped and that due to regional regeneration programmes around the UK, empty homes in other parts of the country will be refurbished and utilised whilst the building of new homes decreases by 20% by 2050. The model assumes that new homes are built in areas with existing infrastructure, leading to a lower need for additional roads, and other new services. This helps to reduce emissions in the Built Infrastructure sector.	1.18	No change is modelled before 2025 From 2025 to 2050, new house building is reduced by 20%
Reduce over-ordering and reuse over-ordered material	See similar measure in built infrastructure section above.	0.12	Over-ordering reduced by 14%. 75% of the over-ordered materials reused or reclaimed elsewhere Overall CO_2 saving of 2.3% by 2020.
Local sourcing	See similar measure in built infrastructure section above.	0.09	Embodied CO_2 of all construction materials reduced by 2% through local sourcing by 2020.
Manufacturing efficiencies	See similar measure in built infrastructure section above.	1.54	Manufacturers of building products improve efficiency by 40%.

Measure	Description	Annual Saving by 2050 ($MtCO_2$)	Assumptions
Recycled content in construction materials	See similar measure in built infrastructure section above.	0.22	Increased recycled content results in CO_2 saving of 9.6% by 2020.
Low impact materials	See similar measure in built infrastructure section above.	0.20	10% saving of embodied CO_2 through low impact material choices by 2020.
Alternatives to diesel	See similar measure in built infrastructure section above.	0.93	Diesel powered plant accounts for 10% of built infrastructure emissions Diesel alternatives become available from 2025 By 2050, diesel alternatives have resulted in a 75% CO_2 saving on construction sites
Durable materials	See similar measure in built infrastructure section above.	0.09	Assume durable material choices result in CO_2 saving of 2% by 2020.
Freight efficiencies	See similar measure in built infrastructure section above.	0.43	Assumes that 20% of built infrastructure emissions are due to freight. Freight efficiency measures result in a 45% CO_2 saving by 2025.

Table 13: CO_2 Reduction Measures Modelled for Public Services

Measure	Description	Annual Saving by 2050 ($MtCO_2$)	Assumptions
Renewables Directive	As above.	1.19	30% renewable electricity by 2020 50% by 2050
100% renewable electricity	As above.	1.09	95% renewable grid mix by 2030 100% renewable by 2050
Zero carbon heating in public sector buildings	Heating accounts for around 30% of the CO_2 emissions in this sector. This measure represents an ambitious scenario of 70% of all public sector buildings achieving zero carbon heating by 2025 and 100% by 2050. Public sector buildings have an opportunity to lead the way on biomass heating schemes and on district heating networks that tap into the CHP schemes planned in the CCAP, as it can often be more practical and cost effective to procure and fit these systems in large public buildings where demand patterns are predictable.	3.78	Assumes heating is 30% of emissions in this sector Assumes 70% of all public sector buildings achieve zero carbon heating by 2025 and 100% by 2050
Reuse of furniture	The model uses REAP and BL3[79] to estimate that furniture and equipment account for around 10% of CO_2 emissions from the public services sector. This measure represents a reduction in this area through greater reuse and through lowering turnover of these items. There are numerous reuse initiatives across London making use of items disposed of whilst still in very good condition, and this measure assumes expansion of in the reuse sector. Government bodies have the opportunity to take a lead roll in prioritising reuse in its own operations. This measure assumes that reuse of furniture and equipment can be enabled through specific initiatives such as a School Furniture Reuse Initiative. Given the large number of schools being rebuilt and refurbished under the Building Schools for the Future Programme, this model assumes a newly established coordinated network for this sector. Similarly, the health sector has potential to prioritise reuse.	0.25	Assumes furniture and equipment account for 10% of CO_2 emissions in this sector Reuse of furniture and equipment results in 20% CO_2 savings

Measure	Description	Annual Saving by 2050 ($MtCO_2$)	Assumptions
Paper saving and recycling loops	The model uses REAP and BL3[80] to estimate that office paper accounts for around 5% of CO_2 emissions from the public services sector. In the NHS Carbon Study[81] it accounts for 5% of total footprint and 9% of the procurement impacts. As with similar measures modelled for other sectors above, this measure incorporates reduced paper consumption through simple efficiency measures and use of local paper loops which can give CO_2 savings of up to 50%[82].	0.50	Assumes 5% of business services CO_2 emissions are due to paper consumption Half of all paper consumption shifts from virgin pulp to local paper loop production resulting in a 40% CO_2 saving
Business travel reductions	Assessments using BL3[83] suggest that business travel accounts for around 10% of total emissions in this sector. This measure allows for policies that reduce the need for travel, improve fleet efficiencies and eco-driving training for employees. In the longer term, a shift towards alternative low carbon or zero carbon vehicle fuels is assumed. (See the transport section for more details).	1.51	Assumes 10% of business services impact is due to business travel. 60% of this is due to air travel, and 40% land based travel. 80% reduction achieved through 50% reduction in air travel and aviation efficiencies. Reduction in car use and eventual move to low carbon cars.
Procurement policies	All government departments, local authorities and public bodies such as the NHS have huge scope to mitigate their impacts through effective procurement policies. This measure assumes gradual sustained savings building up to 30% by 2050.	3.50	Assumes 50% of CO_2 emissions in this sector occur in the procurement supply chain Assumes 30% savings in CO_2 emissions of all procured goods and services by 2050

Table 14: Modelling of domestic energy

Measure	Description	Annual Saving by 2050 ($MtCO_2$)	Assumptions
Renewables Directive	As above. *This measure is not shown in the model because it overlaps with the CCAP measures.*	4.50	30% renewable electricity by 2020, 50% by 2050.
100% renewable electricity	As above.	4.04	Grid renewable energy mix increases from 50% in 2025 to 100% in 2050
Domestic new build	The CCAP intends 30% of new developments to be built to 50% higher standards	0.43	CCAP measures are successfully implemented
Behavioural change	The CCAP assumes behaviour change such as turning off TVs and lights, unplugging chargers, not overheating houses. These are simple and cost free but can be hard to achieve at a population level. The CCAP aims for 60% of households cutting their electricity demand by 10%. Smart metering is one mechanism for facilitating these changes. In these cases energy consumption is made visible to the consumer as it is used. Smart metering trials in Europe and North America have shown energy savings of 5-10 per cent.	1.55	CCAP measures are successfully implemented
Thermal efficiency	The CCAP aims for 40% of households cutting heat demand by 15%. Space heating is the single largest source of domestic CO_2 emissions. The main ways of improving thermal efficiency of a dwelling include insulating hot water tanks, lofts, cavity and solid walls, replacing boilers and heating controls, double or secondary glazing and draught-proofing.	0.86	CCAP measures are successfully implemented

Measure	Description	Annual Saving by 2050 ($MtCO_2$)	Assumptions
Lighting & appliances	Significant savings are already being made through the roll out of low energy light bulbs. The Government, retailers and energy companies are working together to phase out inefficient light bulbs. It has also been announced that the rest of the European Union will be phasing out inefficient light bulbs from 2009. Appliances account for nearly a quarter of domestic CO_2 emissions. Energy efficient models are now available for 50% of products and typically use 30-70% less energy. If all appliances in homes were energy efficient, this could translate into savings of £150 million off electricity bills and cut 620,000 tonnes of CO_2 emissions annually. The CCAP aims for 70% uptake on efficient lights & appliances leading to 70% improvement	1.98	CCAP measures are successfully implemented
Energy supply	The CCAP aims for a quarter of London's energy supply to be moved off the grid and on to local, decentralised systems by 2025, with more than half of London's energy being supplied in this way by 2050. The range of measures to deliver this are: • Combined cooling heating and power could deliver 31% of the energy savings in the energy supply. • Energy from waste and biomass could deliver 15% of the savings. These technologies are a mix of anaerobic digestion, pyrolysis and gasification, and mechanical biological technology. • Micro-generation technologies on domestic homes could deliver 7% of the savings.[84] The CCAP assumes that these measures within London's energy infrastructure will be complemented by a national grid energy mix of 20% renewables.	3.80	CCAP measures are successfully implemented
Additional LCCAP measures	This measure assumes that in addition to the London based CCAP measures being successfully implemented, the CCAP's recommended measures for national and EU government are also successfully implemented. These measures include the introduction of carbon pricing, feed in tariffs and a national grid renewable mix of 50%.	5.99	CCAP national and EU recommended measures are successfully implemented

Measure	Description	Annual Saving by 2050 ($MtCO_2$)	Assumptions
Microgeneration	EST suggested microgeneration could provide 30-40% of UK's electricity needs and help reduce annual household carbon emissions by 15%. Taking this optimistic scenario, and taking into account the a measure of microgeneration is already being achieved in the Climate Change Action Plan, it is assumed that a much greater rollout of these technologies will be possible going forward up to 2050 due to innovation and beneficial pricing systems.	1.34	30% of the most optimistic EST scenario is achieved.

Table 15: Modelling the transport emissions

Measure	Description	Annual Saving by 2050 ($MtCO_2$)	Assumptions
Renewables Directive	As above. With current transport patterns this measure only provides a 4% saving of CO_2 emissions. This is to be expected as most transport emissions are due to direct fuel emissions from vehicles.	1.02	30% renewable electricity by 2020, 50% by 2050.
100% renewable electricity	As above. With current transport patterns this measure only provides a 3% saving of CO_2 emissions. This is to be expected as most transport emissions are due to direct fuel emissions from vehicles.	0.93	95% renewable grid mix by 2030, 100% renewable by 2050.
CCAP London based actions	This measure assumes successful delivery of the CCAP London based actions on transport. The CCAP sets out the following: • 10-20% reduction can be achieved by making lower-carbon forms of travel (public transport, walking and cycling) more attractive, to deliver mode shift. Better public transport, travel demand management and road pricing will be critical in achieving this shift. • More efficient operation of private and public transport can deliver 10-20% savings. • 5-10% savings can be achieved through "eco-driving" (for example smoother acceleration) on all modes, including buses, underground, freight and private vehicles. • Private and public transport infrastructure can become more energy efficient (for example through adoption of hybrid technology). This can deliver 20-30% emissions savings across the network. • Use of lower-carbon fuels such as low-blend biodiesel is likely to be able to contribute a 10% reduction in emissions.	3.50	Assumes that CCAP London based actions on transport are implemented successfully
CCAP national and EU actions	This measure represents delivery of the CCAP national and EU based recommendations on transport. It assumes that additional savings are made via the measures listed above but assisted by national and EU policy. For example the measure assumes a national approach to carbon pricing (as recommended by the government's Stern Review) to provide fiscal and other incentives for energy efficiency and the development of new, lower carbon technologies.	2.30	Assumes that CCAP national and EU based recommendations on transport are implemented successfully

Measure	Description	Annual Saving by 2050 ($MtCO_2$)	Assumptions
Aviation efficiencies	Aviation is a challenging sector to decarbonise and also currently has high growth rates. Since the early 1990s, passenger numbers have grown by 7% a year in the UK and the CO_2 emissions from planes have tracked this rise, despite the improved efficiencies in modern aircraft. Measures for achieving aviation efficiencies include: management techniques such as coordination of air-traffic control systems across Europe to shorten flight paths, reduced taxiing and less circling, which could could cut CO_2 emissions by 10%[85]; and the development of more efficient airplanes (e.g. with propeller engines).	1.81	Assumes a 10% savings from management and 30% savings from efficient engines achieved by 2050.
Less flying overall	Emissions from air travel represent 19% of the total in this sector and are growing by approximately 7% per year[86]. This measure assumes that growth in personal air travel ceases and starts to reduce.	6.32	Assumes domestic flights are reduced to zero by 2050 Assumes international flights are reduced to 50% by 2050
Car efficiencies	This measure assumes widespread take-up of electric vehicles in London from 2025. A London Electric Vehicle Partnership has been created to facilitate this, and support for electric vehicles was a key component of the Government's recent strategy for 'Ultra-low carbon vehicles for the UK'[87].	1.97	Assumes electric cars are introduced from 2025 Assumes 75% CO_2 savings by 2050
Car clubs	Typically one car club vehicle displaces the need for five privately owned cars. London's extensive public transport system makes it highly suited to car clubs and this has been demonstrated by the rapid growth in London car clubs over the last 6 years. From no car clubs in 2002, London now has 1045 car club cars in London, 28080 members and 4 main operators. Reducing car ownership reduces the embodied emissions of a car and its maintenance which represents approximately 40% of the impacts of driving. This measure conservatively does not assume any reduction in mileage due to car clubs but it does assume a 50% reduction in car ownership by 2050.	2.59	50% reduction in car ownership by 2050.

Measure	Description	Annual Saving by 2050 ($MtCO_2$)	Assumptions
Public transport	The London Climate Change Action Plan already includes details on measures to achieve a more efficient public transport system. However, going forward after 2025 there is still considerable scope for further decarbonisation of public transport. This measure assumes a significant rollout of technologies such as hydrogen fuel cell buses and hybrid electric buses, wider electrification of the railway network and biodiesel for trains.	2.37	60% carbon savings achieved for tube, buses and rail network by 2050.
Increase in working from home	This measure assumes 20% of those people who can work from home do so. However, the CO_2 savings are modest. It may be possible in the future to increase the number of people who can work from home by creating more flexible working environments and making more use of IT.	0.14	Increase in people working from home of 20% for those who can work from home[88].

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Appendix B: Workshop summary

A stakeholder workshop to discuss early outputs from the modelling work was held at the Royal Society of the Arts on 9 March 2009.

Delegates included representatives of

- Aldersgate Group
- Arup
- Defra
- Camden Council
- Carbon Disclosure Project
- Carbon Limited
- Commission for a Sustainable London 2012
- Environment Agency
- Forum for the Future
- Friends of the Earth
- Giraffe Innovation
- GLA Group Responsible Procurement team
- Global Action Plan
- Knowledge to Action LLP
- London Borough of Islington
- London Sustainability Exchange
- Metropolitan Police Service
- New Economics Foundation
- Olympic Delivery Authority
- Royal Borough of Kingston upon Thames
- Transport for London
- WRAP.

The workshop specifically addressed London's consumption emissions where there is:

- A significant impact on London's carbon footprint
- A clear opportunity for new policies at the regional level; and
- Potential for London-level action to create positive change.

Four key areas were identified that meet this criteria: food, built infrastructure, consumer goods and government and private services. For each of the areas, sessions were held to:

- Review and test measures included in the model;
- Map out existing programmes and activities achieving carbon savings;
- Consider social, health, inclusivity and economic implications of the measures;
- Identify gaps and opportunities for future action, particularly at the city level.

Outputs from the workshop have been used to inform this report, and we are grateful to workshop participants for their contributions.

Endnotes

1 A 'carbon budget' is the total amount of emissions that can be safely emitted in order to meet a target trajectory.

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3 'Securing the Future', the Government's Sustainable Development Strategy (2005), describes SCP as follows: "Sustainable consumption and production is about achieving more with less. This means not only looking at how goods and services are produced, but also the impacts of products and materials across their whole lifecycle and building on people's awareness of social and environmental concerns. This includes reducing the inefficient use of resources which are a drag on the economy, so helping boost business competitiveness and to break the link between economic growth and environmental degradation." http://www.defra.gov.uk/sustainable/government/publications/uk-strategy/documents/SecFut_complete.pdf

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8 SIC is the UK Standard Industrial Classification of Economic Activities and COICOP is the international Classification of Individual Consumption According to Purpose

9 See Appendix B for a list of workshop participants.

10 The emissions figures quoted here are indicators of consumption by residents and should not be confused with local authority figures reported through National Indicator 186 which is measured on a production basis.

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