Action Today to Protect Tomorrow

The Mayor's Climate Change Action Plan

MAYOR OF LONDON

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Foreword by Ken Livingstone, Mayor of London

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It is almost impossible to exaggerate the danger of climate change. I have no doubt that it is the single biggest threat to the future development of human civilisation.

When scientists talk of the threat of catastrophic climate change they don't just mean the inconvenience of extra flooding or the Tube being unbearably hot in summer. If no action is taken to cut carbon emissions we face temperature rises of over five degrees towards the end of this century. It took a temperature *drop* of just five degrees to cause the last ice-age, so the impact of a temperature increase of the same level would be profound. The map of the world would be changed beyond recognition as sea levels rise, and hundreds of millions of people would be displaced by drought, starvation and the increased ferocity of extreme weather events.

Collectively, we have been complacent about global warming for far too long. It is 10 years since the Kyoto Protocol was signed and still global carbon emissions continue to rise. All of us have a responsibility – actions taken at an individual level can have consequences that are unacceptable for society as a whole. Buying a gas-guzzling 4x4 vehicle is an 'individual choice' but it creates carbon emissions that contribute to global warming and harm everyone. It should be no more sociably acceptable than to claim the right to dump rubbish in the street.

Global warming has to be tackled at a city, national and international level. Human civilisation has developed so much that our actions affect the functioning of our entire planet.

I hope for the sake of our children and grandchildren that we can still prevent catastrophic climate change, but to do so we have to act with great speed and decisiveness.

The aim of this plan is to deliver decisive action in London with the urgency that is required.

Nicholas Stern's formidable review for the Chancellor on the 'Economics of Climate Change', published in November 2006, demonstrated conclusively that the cost of swift action to reduce carbon emissions will be small (one per cent or less of national income) but that the costs of doing nothing and then trying to clean up the mess later will be much higher. I fully endorse the approach adopted by Stern.

This action plan shows that many measures that will deliver the quickest carbon emissions reductions in London will also deliver net financial benefits within a fairly short space of time - improving the comfort of London's homes and offices and putting money back into the pockets of Londoners and London businesses. Those longer run measures that will impose higher costs in the short term, will still work out as a good investment compared with the costs of doing nothing and allowing catastrophic climate change to develop.

The simple message is this: to tackle climate change you do not have to reduce your quality of life, but you do have to change the way you live. The present model of huge energy production followed by huge energy waste - in the losses from power stations, from houses, from commercial property, and from transport - is utterly inefficient and is irreparably damaging the planet. There must be a decisive shift to an economy in which energy is conserved, not wasted, and therefore in which far less energy needs to be produced per unit of economic activity.

The fundamental cause of global warming is the profligacy with which we have exploited global energy resources over the past century. A strategy to cut carbon emissions is essentially about cutting out waste and improving efficiency.

This is a problem everyone has both a stake in resolving and genuinely can do something about through their changing their own behaviour. From turning off appliances when they're not being used, to installing renewable energy supplies to their house, if every Londoner decides to play a part in cutting our carbon footprint the cumulative effect will be considerable.

But even such individual action alone won't be enough. The plan sets out a series of measures that I will take as Mayor, including to enable Londoners and businesses to use energy more efficiently; to change fundamentally the way London is supplied with energy; to maintain London as a world-leader in sustainable transport; and to ensure that new development in our growing city is of the highest environmental standards - fit for a very different future.

London businesses and business leaders have been at the forefront of raising awareness of the threat of climate change and business has a major part to play in reducing London's carbon footprint. This plan sets out a series of ways in which I will support and work with them to make London's business sector a beacon of carbon-friendly commerce.

Indeed, by placing ourselves at the forefront of tackling what is likely to be a defining issue of the twenty first century, London has a real opportunity to develop its own economy. I want London to become the world's leading centre for research and financial development on climate change during the next five years.

To achieve this requires, first, clarity that London is determined to tackle climate change; second, the most sophisticated financial institutions to respond to carbon trading and investment technologies; and third, state of the art scientific and technical research facilities to develop the technologies of the future.

A number of cities can offer some of these solutions, but only London can offer all three. I will do my part by ensuring that climate change continues to be the number one priority for my administration.

This action plan demonstrates that London can make deep and meaningful cuts in its emissions through actions by London public authorities, by businesses, and by individual Londoners. For the next ten years we can meet the target reductions that scientists say are necessary.

The difficult truth, however, is that without action at a national and international level we cannot continue to achieve this through to 2025 and beyond.

Most fundamentally, the government has to take rapid action to introduce a comprehensive system of carbon pricing.

Nicholas Stern called climate change 'the greatest ever market failure', and he was completely right. While the price of a product or service continues to ignore its impact on global warming in the form of carbon emissions it will be impossible to persuade businesses and individuals to take the full scale of actions that are necessary to avert catastrophic climate change.

Working with the government to introduce a comprehensive system of carbon pricing in the UK, in Europe, and internationally will be one of my top priorities.

Action at national and international level is often slow and difficult. That is why we have also established the C40 - a forum of the largest cities in the world, in partnership with the Clinton Foundation, to accelerate emissions reductions among cities.

A parallel development to this has started in the United States - whose government has refused to sign the Kyoto Protocol on climate change. The action of the Mayor of Seattle, Greg Nicholls, in pulling together at first a handful of US cities willing to sign up to the Kyoto Protocol's demands has stirred a change in attitude to climate change in the world's most polluting nation, although there is still a long way to go before the US actually starts to cut its emissions. Over 400 cities and states have now joined Seattle.

Every generation faces at least one great challenge. The challenge of the twenty first century is climate change. It is a challenge that absolutely everyone can play a part in tackling and which we must win. I look forward to working with Londoners to achieve this.

Ken Livingstone, Mayor of London

Foreword by Nicky Gavron, Deputy Mayor of London

As London's deputy Mayor, I have been working closely with the Mayor to make tackling climate change our overriding political imperative. This is because when it comes to practical action cities are centre stage – and London's leadership in this is crucial.

Why? Because most of the world's cities, including London, are growing rapidly. Already cities consume three quarters of the world's energy and are responsible for eighty percent of all carbon emissions. We will fail in our efforts to save the planet if the emissions trend in cities is not reversed. London, as the pre-eminent world city, has a prime responsibility to act. And we are acting.

First, through our planning policies and the London Climate Change Agency we are spearheading a decentralised energy revolution here in London. Remote centralised power stations are the primary cause of climate change: they waste their heat and lose power through national grid transmission. Our solution is to decentralise power, generating it locally so that the heat can be used to warm and cool our buildings. London has a quarter of the country's combined heat, power and cooling capacity. This means we can have a huge impact on reducing emissions and saving money.

Secondly, we are introducing policies and projects which cut across those institutional boundaries which keep the big carbon producing sectors – energy, waste, transport and water – separate. For instance, the treatment of sewage by water companies, or the management of huge organic and residual waste streams, could produce a whole new market in renewable gases and liquid fuels –turning non-recyclable waste into London's largest source of renewable energy. This energy can be used for heating and cooling homes and workplaces and for transport.

Thirdly, a major source of carbon emissions in London is from homes and work places. Here we can all show leadership – personally, professionally and corporately – by taking immediate action to use less energy. Proposals in this plan, backed by strong government action, will make it easier for people to cut their carbon consumption and even become energy suppliers to the grid.

These three major planks of our action plan will only realise their full potential to reduce carbon emissions if government removes the barriers currently holding back the roll-out of decentralised energy and the large-scale production of renewable gases and liquid fuels from waste.

The Mayor and I are working closely with government to turn these proposals into a reality. The UK may only account for two percent of global emissions, but if its cities and citizens are seen to act to cut their carbon emissions and increase energy efficiency, then cities across the world will join us. This is why the Action Plan and London's leadership are vital.

Nicky Gavron, Deputy Mayor of London

Foreword by Sian Berry, principal speaker, the Green Party

Over 80 per cent of the world's population live in coastal areas or - like Londoners - on the tidal range of major rivers. Rising sea level is just one of the obvious reasons why we have to take climate change seriously.

In the past six years the Thames Barrier has been raised to prevent flooding a staggering 56 times, compared with just three times in the first six years after its construction in the 1980s. Over 150 square kilometers of London lies below high tide level, putting the homes of 750,000 Londoners at risk of flooding.

London could become the greenest major city in the world but that will mean reversing many of the mistakes of the past. We need to design our city so that local shops and services are within an easy walk for all and create streets that are as friendly to cyclists as those in Amsterdam. We need a first-rate public transport system that means people leave their cars behind and get onto zero-emission buses and efficient tube trains that run on renewable energy.

Above all, we have to change the way we use energy at home. We can change planning rules so that we only build zero-carbon homes that are green as well as cheap to run. We can do much more to help homeowners, landlords and businesses to make existing buildings more efficient. Instead of building new nuclear power stations, whose waste has to travel past Londoners' backyards, we can generate electricity and heat locally and move from being energy users to becoming energy producers.

This action plan outlines important steps towards a greener city. Greens in London will be working hard to make sure the ideas in this document are implemented, not left on the shelf next to the fine words and empty promises of the past.

These steps are absolutely necessary, but we know that we need to go much further in the long term. A truly sustainable future demands more radical action than this plan can deliver and, in addition to what we can do for ourselves now, Londoners will need the commitment and support of central government if we are to achieve this. But we can lead the way with our actions in London.

Individuals, businesses and elected representatives can all do their bit to tackle the crisis of climate change. If we all act together, we really can change our world for the better.

Sian Berry, Green Party principal speaker

Executive summary

The challenge

Climate change is the biggest threat to the future development of human civilisation and poses a huge challenge for cities like London. The possibility of global climate change catastrophe can only be reduced by the world making deep and immediate cuts in its emissions of greenhouse gases, especially of carbon dioxide. This plan sets out how London will contribute and show leadership in meeting this global challenge.

The impact on Londoners and the economy

The core message of this Climate Change Action Plan is that Londoners do not have to reduce their standard of living for London to play its part in tackling climate change, but we do all have to change the way we live.

We have to move from a high energy-using, wasteful economic model to one that conserves energy and minimises waste. In other words we have to be more efficient.

As our focus is on efficiency, many of the measures advocated in this plan will deliver net financial benefits over a relatively short period of time, as well as cutting emissions. And as the government's comprehensive 'Stern Review' of the economics of climate change demonstrated, it will be far cheaper to invest now to reduce carbon emissions, rather than ignore the problem and face far higher costs in the future.

London's contribution to climate change

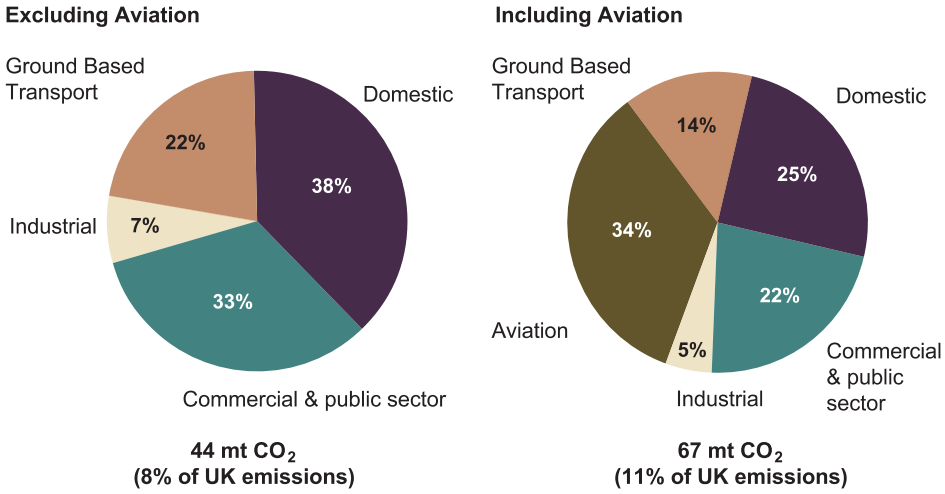
The United Kingdom is the world's eighth largest emitter of carbon dioxide. London is responsible for eight per cent of these emissions, producing 44 million tonnes of CO_2 each year. Unless we take action, emissions are set to increase substantially. Given London's forecast economic and population growth, London's emissions are projected to increase by 15 per cent to 51 million tonnes by 2025.

These figures exclude emissions from aviation, which are not part of CO_2 reductions obligated under the Kyoto Protocol and are not routinely included in the UK government's assessment of emissions.

With aviation currently accounting for only 2-3 per cent of global CO_2 emissions, this may seem quite reasonable. However, London's role as an international aviation hub means that aviation emissions account for 34 per cent of its total carbon footprint. Evidence further suggests that emissions from aircraft, because of the altitude at which they are emitted, can have twice the impact of ground-based emissions. Continued dramatic growth in flight numbers is also predicted, which implies that as the century progresses the contribution of aviation to climate change is likely to become very significant.

As such, the Mayor believes it important to consider aviation in his Climate Change Action Plan and it is the subject of a whole chapter of this document (Chapter 4.6). However, as aviation emissions can only be tackled through national and international action they have not been included in the core figures in other chapters.

Figure i 2006 carbon dioxide emissions from London



Note 2006 figures are based on latest available LECI data (for 2003) projected to 2006 based on projections for each sector

Source London Energy and CO_2 Emissions Inventory; DEFRA

London's record so far

London has a good record in addressing climate change compared with most cities. Over the past six years we have become the only major city in the world to achieve a shift away from private car usage to public transport, cycling and walking - stabilising our emissions from road traffic, while everywhere else they are rising. In part, this has been driven by the pioneering move to charge vehicles entering central London, which has cut carbon emissions by 16 per cent within this zone.

The regulations set out in the Mayor's current London Plan ensure that new developments in London now achieve higher environmental standards than elsewhere in Britain; for example, 10 per cent of energy needs must come from on-site renewable power wherever feasible.

The Mayor has also established the London Climate Change Agency to help move London towards more efficient, lower-emission forms of energy supply. And in 2005 the Mayor established the C40 Large Cities Climate Leadership Group, which is now working to accelerate emissions reductions in many of the world's largest cities.

But even these positive steps are not enough. That is why the Mayor has produced this action plan.

The targets

Tackling climate change clearly requires global action. The Mayor supports the broad view that this should be achieved through a process of 'contraction and convergence' - with the largest industrialised nations that have caused climate change required to significantly reduce their emissions, while newly developing nations are permitted to increase emissions up to a point where emissions converge and stabilise at a level which avoids catastrophic climate change[1].

Once carbon emission levels have stabilised at a safe level, the world needs to operate on the basis of 'carbon democracy'; that is, that the world agrees a maximum level of global emissions and every individual is entitled to emit an equal proportion of carbon emissions within that.

The science of global warming is still developing, but the growing scientific consensus is that stabilising atmospheric CO_2 concentrations at 450 parts per million (ppm) is required to avoid catastrophic climate change. Current levels are around 380ppm - up from levels of 280ppm maintained for most of human history prior to the industrial revolution.

Stabilising global carbon emissions at 450ppm on a contraction and convergence basis means that London has to limit the total amount of carbon dioxide we produce between now and 2025 to about 600 million tonnes[2]. Meeting this CO_2 budget will require ongoing reductions of 4 per cent per annum. This implies a target of stabilising London and the UK's emissions at 60 per cent below 1990 levels by 2025. This compares to the existing UK government aspiration of a 60 per cent reduction from 2000 levels by 2050. This plan adopts these targets and prioritises actions across all sectors to achieve them.

London has to limit total carbon dioxide between now and 2025 to 600 million tonnes

Achieving the targets

There is no technical barrier to achieving these targets. However, the difficult truth is that in preparing this action plan we have been unable to present any realistic scenario in which we can achieve the 2025 target set out above, without a small number of key national regulatory and policy changes.

The problem is that existing taxation and regulation policies do not ensure that the costs of carbon emissions are taken into account in setting the price of most products and services. As a result, there are insufficient financial incentives for businesses and individuals to take the kinds of action necessary to cut carbon emissions on the scale that is necessary.

An absolute priority for the Mayor, therefore, is to work with national government to introduce a comprehensive system of carbon pricing. Such a system will catalyse further technological development and commercialisation, and indeed creates opportunities for London to host carbon-trading markets, invest in green funds, and research, develop and finance new zero and low-carbon technologies.

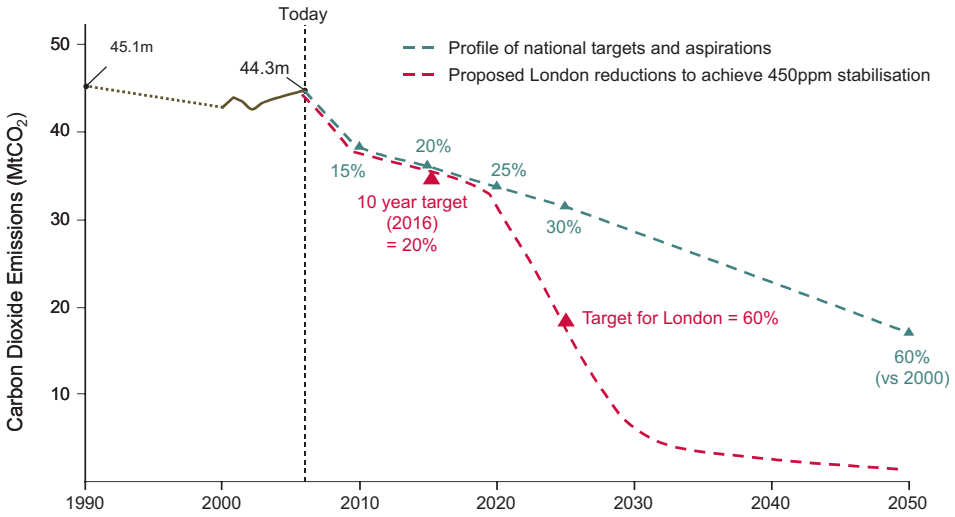
Regardless of what emissions stabilisation target is adopted for 2025, the scale of reduction we need over the next ten years is about the same. To put it another way, whatever the ultimate goal we have to implement immediately measures that are already cost-effective and will deliver major emissions reductions.

Ten years is also about the longest timeframe over which we can make realistic assumptions about future legislative or technological change.

This plan, therefore, focuses on what can be achieved over the next 10 years, but in the context of the types of changes that will be needed by 2025 and beyond.

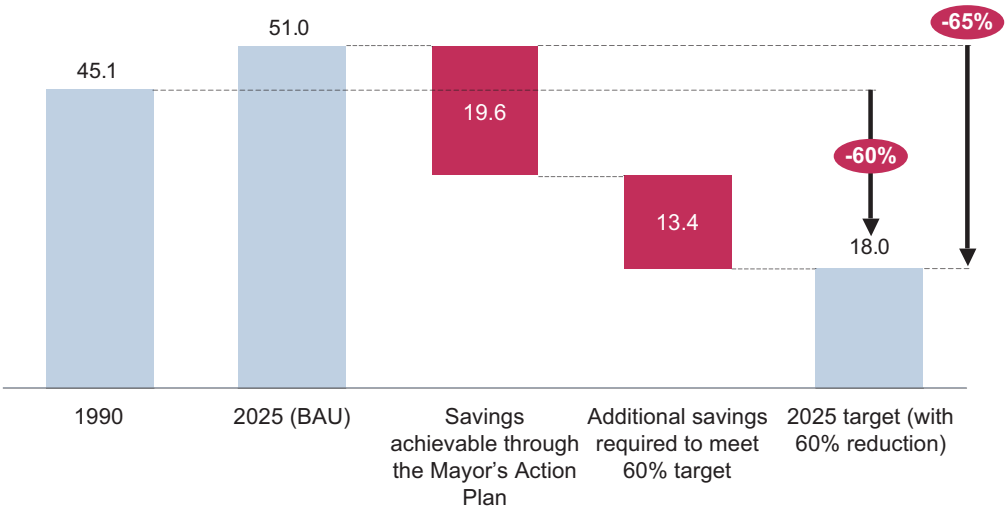
The graph below illustrates the core scenarios that this plan has considered. It shows that with the actions set out in this plan London can hit its 2016 10-year milestone, but without much more rigorous national and international action - including introducing widespread carbon pricing - we will divert from this path and by 2025 London's emissions level will have stabilised at just 30 per cent below 1990 levels, twice as high as that required. As a result, London will not make its full contribution to stabilising atmospheric CO_2 concentrations at 450ppm.

Figure ii Potential London CO_2 trajectories (excluding aviation)



By 2025, annual CO_2 savings of 19.6 million tonnes compared to business as usual are achievable through actions set out in this plan. Action will be necessary at a national and European level to save the further 13.4 million tonnes needed each year to constrain London's total carbon dioxide emissions to 600 million tonnes between now and 2025.

Figure iii London's 2025 CO_2 reduction target (excluding aviation)
Million tonnes of CO_2



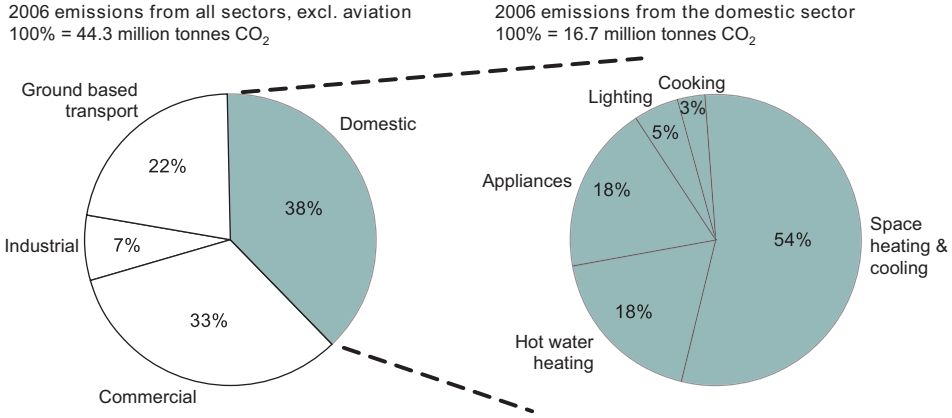
Source London Energy and CO_2 Emissions Inventory; GLA

The sections below summarise how these reductions can be achieved, sector by sector.

Emissions from existing homes

Energy use in existing homes is the largest single source of CO_2 emissions in London, at nearly 40 per cent of the total. This plan sets out how annual domestic CO_2 emissions can be reduced by 7.7 million tonnes by 2025.

Figure iv 2006 CO_2 emissions from London's domestic sector



Note Cooling in the domestic sector represents a small component, currently less than one per cent

Source London Energy and CO_2 Emissions Inventory; DEFRA

If every lightbulb in every London home was energy efficient, London could save 575,000 tonnes of CO_2 and £139 million per year

Roughly half of this reduction can be delivered if just two thirds of Londoners make simple behavioural changes and put some basic energy efficiency measures in place. To give but a few examples, if every light bulb in every London home was energy efficient, it could save 575,000 tonnes of CO_2 and £139 million per year; if all appliances in homes were energy-efficient, this could translate into savings of £150 million off electricity bills and 620,000 tonnes of CO_2 every year. Reductions will also need to come from changes to the carbon-intensity of energy supplied to Londoners' homes.

Critically, because the basis of this plan is to cut waste and improve the efficiency with which energy is supplied and used, measures to reduce carbon dioxide emissions in this sector will result in significant energy bill savings: Londoners could save up to £1 billion per year by 2025, or approximately £300 per year per average household. This will particularly benefit those on lower incomes for whom expenditure on heat and power consumes a large portion of disposable income. Obviously, if fossil fuel energy prices continue to rise, these savings would be even greater.

The key new initiative to deliver carbon dioxide savings from the domestic sector will be the **Mayor's Green Homes Programme**. Around £7 million

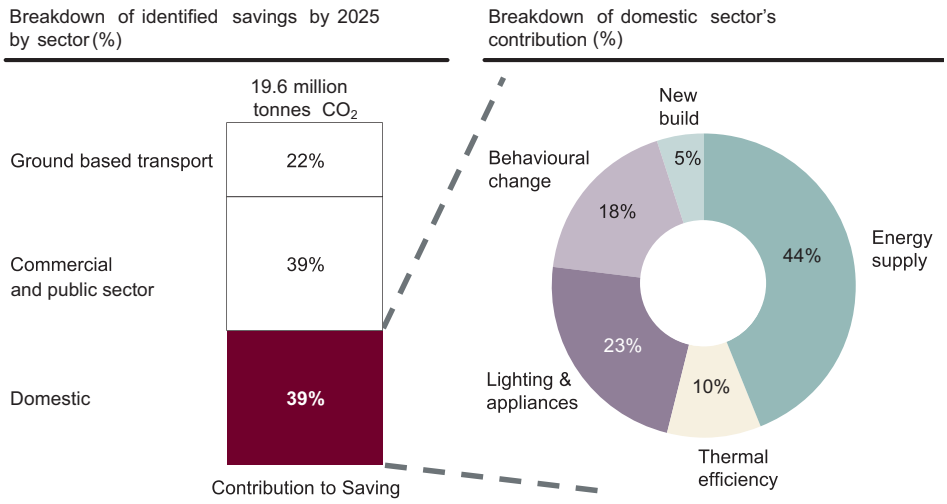
will be set aside in the 07/08 budget to initiate this scheme. But significant additional resources will also be leveraged in from national public and private sector energy programmes and through new partnerships with other organisations. This will include close collaboration with industry to develop the supply chain.

Implementing the Mayor's home energy efficiency programme would save the average London household £300 per year

The Green Homes Programme will include:

- A London-wide offer to homeowners of **heavily subsidised** (and free to those on benefits) **loft and cavity wall insulation**
- A major marketing campaign to **increase awareness** about what actions Londoners can take to cut their emissions and reduce their energy bills
- A new **one-stop-shop advice and referral service**, available to all Londoners, on implementing energy savings measures and installing micro-renewables, which will be accessible by web and by phone. This pioneering service will be delivered in partnership with the Energy Savings Trust
- A pilot Green Homes **"concierge service"**, providing bespoke energy audits and project management of installation of energy efficiency improvements, micro-renewables and water conservation measures for the able-to-pay sector
- A programme of improving the energy-efficiency of London's **social housing stock**
- Identifying skills gaps in the sustainable energy industry and developing **training** (in collaboration with the relevant industry bodies) to improve the skills required to install and service energy saving and micro-renewable products and systems.

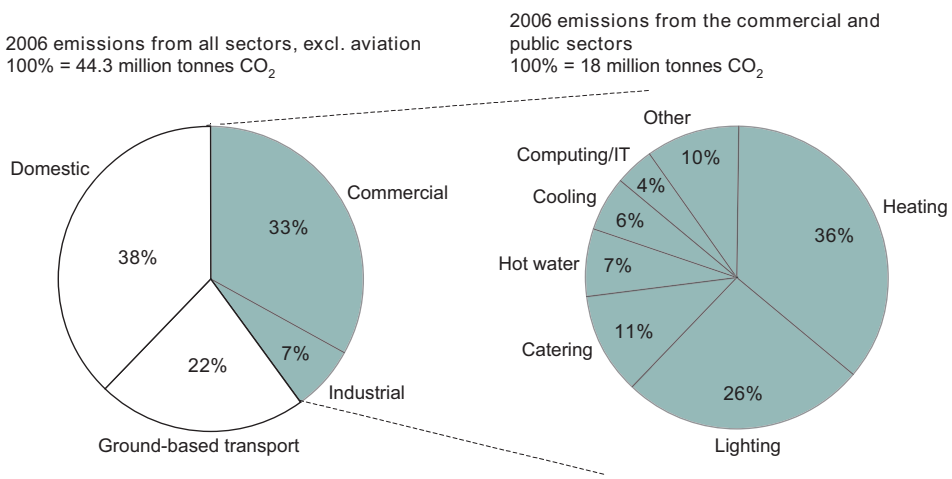
Figure v Domestic sector's contribution to CO_2 savings by 2025



Emissions from existing commercial and public sector activity

Emissions from the commercial and public sector are 15 million tonnes of CO_2 annually (18 million when industry is included)[3]. They come primarily from electricity usage, including for lighting and computing, although as the climate continues to warm, energy used for cooling buildings could become increasingly significant. Substantial savings can be achieved through simple actions like turning off appliances at night and avoiding inefficient heating and cooling of buildings. These carbon savings will also result in significantly lower energy bills, and will boost London's economy and create new jobs by creating demand for services such as energy-saving building refurbishment.

Figure vi 2006 CO_2 emissions from London's commercial and public sectors



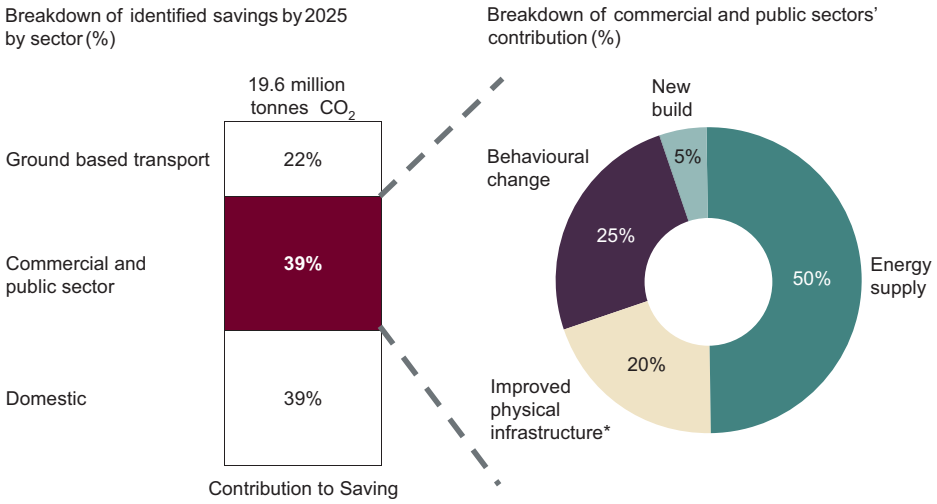
Source London Energy and CO_2 Emissions Inventory; DEFRA

The Mayor will work with the private sector and other public bodies to deliver carbon dioxide savings from existing commercial and public sector activity through a **Green Organisations Programme**. This programme could deliver a reduction of 7.6 million tonnes of CO_2 from annual sector emissions and, when combined with improvements in new build, contributes to an overall reduction in CO_2 of roughly 40 per cent in this sector. The programme will focus on the following key areas:

- **Better Buildings Partnership:** working with and incentivising commercial landlords to upgrade their buildings, particularly during routine refurbishments.
- **Green Organisations Badging Scheme:** working with tenants (both private and public sector organisations) to reduce emissions through staff behavioural changes and improved building operations. This will include providing information and support to deliver these changes, working together with existing initiatives, as well as a clear set of targets and associated green 'badging' levels.
- **Lobbying:** Both the Better Buildings Partnership and the Green Organisations Badging Scheme will be supported by a lobbying campaign focusing on key barriers to the uptake of energy savings and clean energy. The Mayor will work closely with London's businesses and public sector organisations to develop and deliver this programme, in order to build on and benefit from initiatives that are already in train.

If all of London's businesses and public sector organisations introduced simple behavioural changes, CO_2 emissions could be reduced by over three million tonnes per year

Figure vii Commercial and public sectors' contribution to CO_2 savings by 2025



Notes Includes simple energy 'audits' as well as staff measures; improvements to physical infrastructure includes either to building fabric or other operating efficiencies such as installing motion sensor lighting

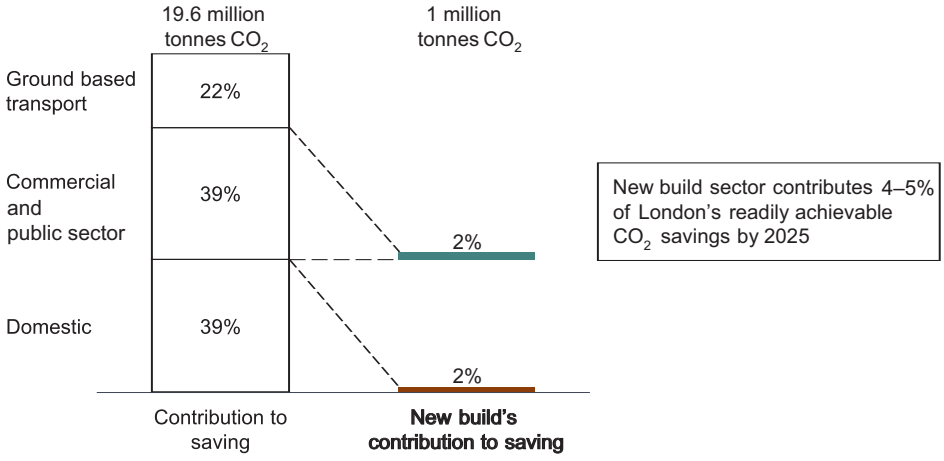
Dense, urban environments can be the most sustainable way to accommodate large populations

Emissions from new build and development

Ensuring that new buildings are designed and constructed to high standards of energy efficiency and renewable energy use is essential if London is to stabilise its carbon emissions at the necessary levels over the medium to long-term. As a significant amount of new construction is expected to take place in London over the next two decades, we have a perfect opportunity to set a new standard in zero and low carbon development, green building design and sustainable land use planning. Dense, urban environments can be the most sustainable way to accommodate large populations, as demonstrated by London's already-low per capita CO_2 emissions (the lowest of any UK region at 25 per cent below the national average)[4].

Roughly one million tonnes of CO_2 per annum can be saved in 2025 through better enforcement of current regulations and the introduction of higher standards for domestic and commercial new build. The major challenge will be to ensure concerted action by all organisations involved (including boroughs, developers and the construction industry) and full implementation of the improved standards.

Figure viii New build sector's contribution to CO_2 savings by 2025



The Mayor's priorities to deliver savings from new build and development are:

- **To revise the London Plan requirements for new developments.** The draft Further Alterations to the London Plan issued by the Mayor require new developments to prioritise the use of decentralised energy

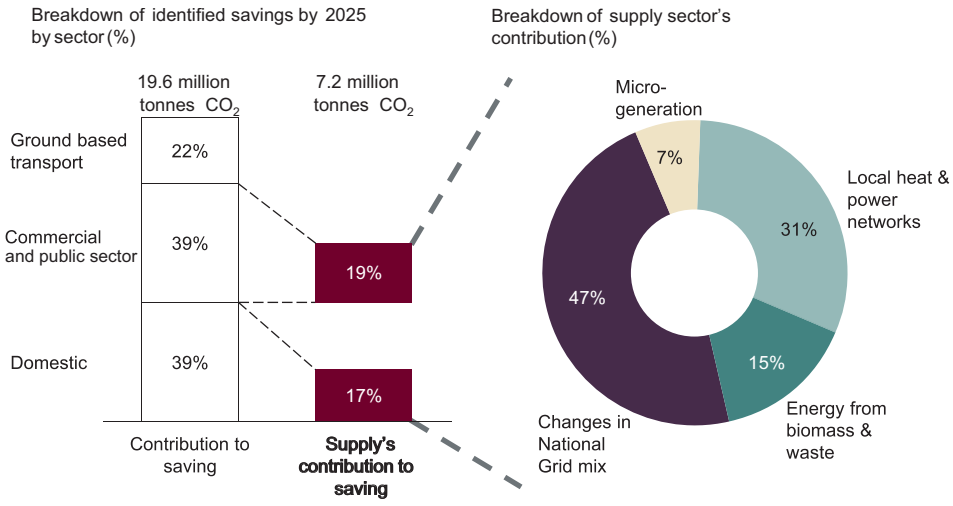
supply, most importantly by connecting to combined cooling heat and power (CCHP) networks

- **Further emphasis on energy efficiency through the Mayor's planning role.** Recent experience within the Greater London Authority has demonstrated what a substantial difference a small number of additional dedicated and knowledgeable resources can make. New energy-focused resources will therefore be added to both the Mayor's Planning Decisions Unit and Environment team
- **A greater focus on energy efficiency at borough level.** To increase sustainable energy and planning skills in the London boroughs and other key stakeholders through a comprehensive outreach programme. This programme will provide training and support for the boroughs, a publicly accessible energy portal and close collaboration with developers to establish the true cost/benefit of compliance with new regulations in London
- **Showing by doing: individual developments and new housing powers.** The Mayor will model exemplary energy-efficiency standards both through individual developments in which the London Development Agency (LDA) is involved, and for all new affordable homes. The Mayor's new Housing Strategy will make energy efficiency a key priority, including achieving the government's recently announced target of 100 per cent new homes as zero-carbon by 2016. All LDA developments will also be developed to the highest standards, building upon experiences such as the Gallions Park zero carbon development.

Energy supply

The single biggest barrier to reducing London's carbon emissions is the way in which energy supplied to homes and offices is produced and distributed. Centralised electricity generation, whether through coal, oil, gas or nuclear power stations, is inherently inefficient - wasting two thirds or more of its original energy input in the form of expelled heat. Further losses occur in the process of distributing electricity from rural power stations to the towns and cities where it is mostly consumed.

Figure ix Supply sector's contribution to CO_2 savings by 2025



The Mayor's top priority for reducing carbon emissions is to move as much of London as possible away from reliance on the national grid and on to local, lower-carbon energy supply (decentralised energy, including combined cooling heat and power (CCHP), energy from waste, and on-site renewable energy - such as solar panels). This approach is often termed 'decentralised energy'.

The Mayor's goal is to enable a quarter of London's energy supply to be moved off the grid and on to local, decentralised systems by 2025, with the majority of London's energy being supplied in this way by 2050. This plan sets out how London could achieve carbon savings of 7.2 million tonnes by 2025 through improved energy supply (note: savings from energy supply are already included in the figures given for emissions reductions from the domestic and commercial sectors).

The Mayor will also encourage the government to enable far more rapid investment in the huge opportunities that Britain, as an island nation, possesses for large scale renewable energy generation.

London's push for a decentralised, sustainable energy supply will include:

- **Dramatically increasing the rollout of combined cooling heat and power energy supply.** The main source of carbon reductions from decentralised energy will come from the combined generation of heat and power locally (CCHP). Through the direct investment of the London Development Agency and the requirements of the draft Further Alterations to the Mayor's London Plan, supplying energy through CCHP will become the norm in major new developments in

London. However, the bulk of CCHP's potential will need to be realised through supplying London's existing building stock. A major vehicle for this will be the Mayor's Climate Change Agency and its joint venture with EDF Energy, the London Energy Services Company.

- **Rapidly developing and delivering mechanisms to produce energy from waste (without incineration).** Energy from waste through new non-incineration technologies (such as anaerobic digestion, mechanical biological treatment, pyrolysis and gasification) offers a carbon-savings potential nearly as large as that of Combined Cooling Heat and Power. If all the London waste that currently goes to landfill were utilised, it could generate enough electricity for up to two million homes, and heat for up to 625,000 homes. However this technology still needs to be explored and commercialised. The creation of a single waste authority for London would have provided a major boost to this work. In its absence, the Mayor will work with boroughs and industry to facilitate and accelerate the potential of energy from waste including pilots and showcasing technologies at several large sites.
- **Promoting the uptake of on-site renewable energy in London.** Small and medium-scale renewable energy generation will be promoted through the revised London Plan standards, the Green Homes and Green Organisations Programmes, and through the Mayoral group's own installations.
- **Pursuing large-scale renewable power generation in London.** There are limited, but significant, opportunities for large-scale renewable power generation in London - for example, land-based wind turbines could supply power to up to 47,000 households. Much greater opportunities for wind power exist in the Thames Estuary, at least enough to supply a million homes, and the Mayor will strongly back projects such as the London Array. We will also investigate the potential for using tidal and wave power from the Thames.
- **Making the case for a greatly accelerated programme of investment in renewable energy in the UK.** The UK has huge untapped potential for renewable energy. In fact, some estimates suggest that renewables could provide nearly 100 per cent of the UK's electricity with offshore wind providing up to 60 per cent of the total. This would be one of the measures with the most significant carbon-reducing impact for London. We will therefore push for simple planning and regulatory changes that incentivise much greater contribution from renewables to the national grid.
- **Supporting carbon sequestration.** While burying carbon emissions underground is not a long-term solution, the Mayor recognises that it is being investigated around the world and will offer significant emissions reductions once commercially viable. We will push for rapid uptake of carbon sequestration to further reduce national grid emissions while the UK achieves a transition to a renewable energy based economy. In the

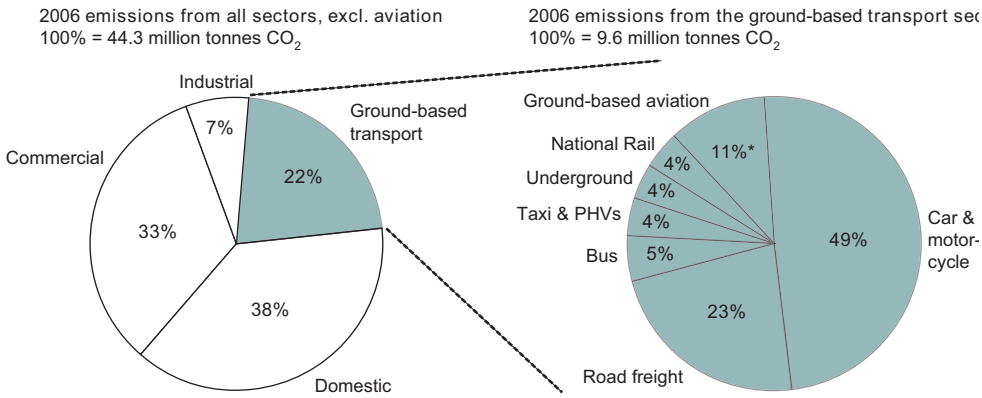
The London waste that currently goes to landfill could generate enough electricity for up to two million homes, and heat up to 625,000 homes

meantime, all new power stations should use the latest technologies to minimise CO_2 emissions and implement heat capture and distribution.

Emissions from ground based transport

London is unusual compared with many large cities around the world in that its emissions from transport (excluding aviation) are relatively small - about 22 per cent of the total. Unlike other sectors, transport emissions in London have stayed flat since 1990 despite the rapid growth of London's population and economy. This is thanks to high long-term levels of public transport use and, since 2000, unprecedented investment in the public transport network, alongside the implementation of policies like the congestion charge to combat congestion and manage traffic.

Figure x 2006 CO_2 emissions from the ground based transport sector



Note Emissions from aircraft whilst taxiing and during the take-off and landing cycle (i.e., below 1,000m in altitude)

Source Mayor's Energy Strategy and TfL analysis

If implemented, the measures in this plan would deliver carbon savings of 4.3 million tonnes by 2025.

CO_2 emissions from road transport would fall by as much as 30 per cent if people simply bought the most fuel efficient car in each class

The top priority now is to reduce emissions from car and freight traffic, since these represent nearly three quarters of emissions in this sector. This includes:

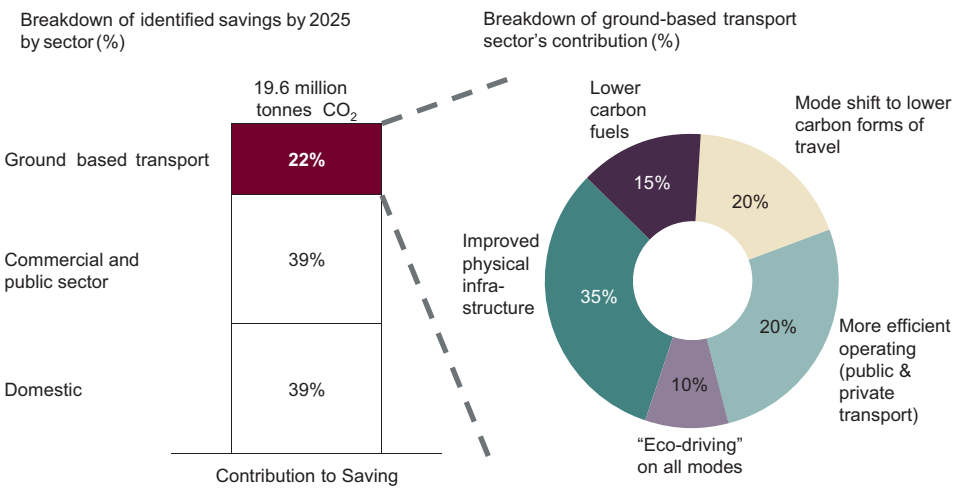
- **Changing the way Londoners travel.** A major programme of continued investment in public transport, walking and cycling to provide attractive alternatives to car travel (as outlined in Transport for London's *Transport 2025* work). It also includes promoting alternatives to the car through marketing, information and other travel demand management policies. London-wide, this can deliver nearly a million tonnes of CO_2 savings per annum.

For an average Londoner, switching from driving to work to taking the bus will save 0.6 tonnes of carbon per year; taking up cycling instead would increase these savings to 1.1 tonnes.

- **Operating vehicles more efficiently.** Simply driving more sensibly can reduce fuel use by 5-10 per cent. The Mayor will promote eco-driving (for example, smoother acceleration/braking and proper vehicle maintenance) by all car, freight, taxi and public transport drivers.
- **Promoting low-carbon vehicles and fuels.** The biggest opportunity for emissions reductions in this sector is from uptake of lower-carbon vehicles and fuels, which alone could cut transport emissions by up to 4-5 million tonnes. CO_2 emissions from road transport would fall by as much as 30 per cent if people simply bought the most fuel efficient car in each class
- **Carbon pricing for transport.** More widespread carbon pricing will be essential to incentivise demand for low-carbon vehicles and fuels, and to drive innovation in further developing these technologies. Comprehensive carbon pricing requires regulatory changes at international, national and regional levels. Having led the world with the Central London Congestion Charge, the Mayor now wants London to become the first major city in the world to charge cars to enter its central business area on the basis of their carbon emission levels. Under this proposal, the highest polluting vehicles will be charged £25 a day, while zero-emission vehicles will travel free.

The Mayor will also pursue an ambitious programme of energy-saving measures across public transport. This includes regenerative braking on the Tube - which allows energy generated in braking to be reused to drive the train, and the conversion of London's entire 8,000-bus fleet to diesel-electric hybrid vehicles.

Figure xi Ground based transport sector's contribution to CO_2 savings by 2025



Aviation

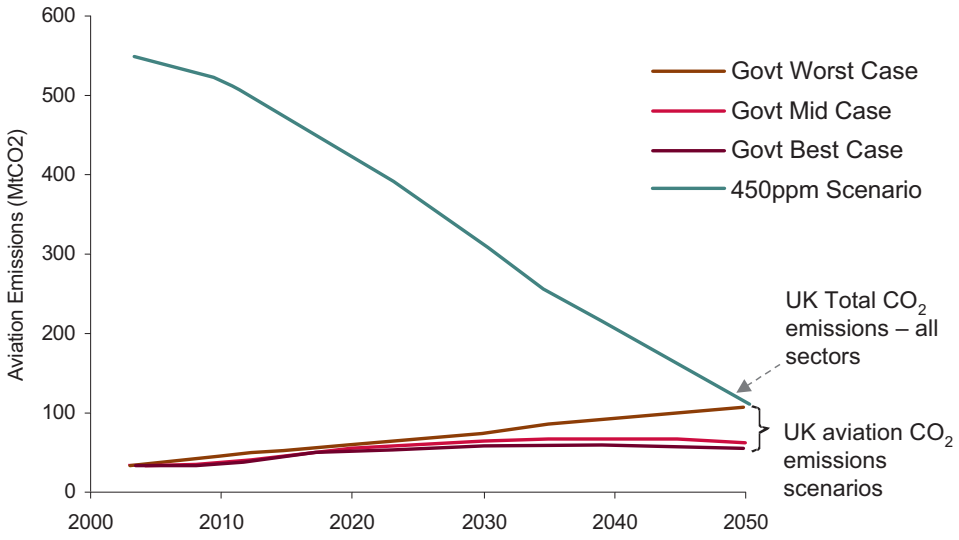
Aviation is one of the most environmentally damaging modes of transport. Per passenger kilometre, air travel is the most CO_2-intensive form of travel, and trips by air tend to cover the largest distances. This impact on the climate is exacerbated by the release of CO_2 and other greenhouse gases high in the atmosphere, where the negative effect of these emissions is more than doubled.

Air travel is also one of the key elements of today's global economy, so curbing aviation emissions presents a global challenge. London is a major UK and international air travel hub, with London's airports handling 30 per cent of passengers entering or departing the UK[5]. London's role in the world economy and its "world city" status depend on maintaining these links with the rest of the world.

Aviation emissions today account for approximately seven per cent of total UK CO_2 emissions. However, forecasts suggest that historic growth rates of 6-7 per cent per annum will continue and possibly increase if the market and regulatory environments remain as they are. This historic and projected growth is driven largely by dramatic growth in leisure trips, which have accounted for over 85 per cent of air travel growth in the UK. The majority of these trips are accounted for by a small percentage of the population, with 10 per cent of people (mostly better off) accounting for fully half of all flights.

As a result of this growth, UK government projections predict a 50-200 per cent increase in CO_2 emissions from aviation in the UK by 2050. This means aviation would account for most of the UK's overall CO_2 budget if the UK is to achieve stabilisation targets being advocated by the Mayor.

Figure xii Overall UK emissions targets compared to government aviation forecasts



Source Tyndall Centre for Climate Change, Royal Commission

In principle aviation fits within the same simple framework that applies to all carbon emissions. In practice, however, the industry poses certain specific issues that must be dealt with and is therefore considered in a separate chapter.

The fundamental principle is that overall carbon emissions must be capped at a level preventing climate change. From this point of view what is important is the overall quantity of emissions not their source. It may be indeed the case, for example, that within an acceptable overall carbon cap in the future society will take more stringent measures to prevent heat escaping from buildings (which produces no benefit) in order to permit more travel (which does have benefits).

However at present two interrelated problems exist. First, the true price of carbon emissions is not built into the price of air travel - meaning each air trip in fact does damage that is not financed. This can only be dealt with by including aviation within a comprehensive system of carbon pricing. Secondly, while this is introduced, the build up of air travel is so rapid that it threatens to overwhelm the benefits derived from limiting emissions in other areas. This means that until a comprehensive system of carbon pricing is introduced physical controls and/or financial disincentives will have to be used to prevent unacceptable damage being done by rising emissions from aviation.

For aviation, unlike most other sectors considered in this report, there are real technological, as well as political and regulatory barriers, to reducing carbon emissions in the short to medium term. That is why much of the public debate has centred on reducing demand for flying.

While the majority of options to reduce the growing impact of aviation are beyond the direct influence of the Mayor, he will act where he can to reduce emissions. These steps will include:

By not being subject to the same fuel duty as motorists the UK aviation industry avoids annual costs of almost £8bn

- **Seeking to influence EU and international aviation policy** including the earliest possible inclusion of aviation in the EU emissions trading scheme (ETS) and levying duty on aviation fuel. We estimate that if the 12.5 million tonnes of fuel consumed by the UK aviation industry were subject to the same duty as motorists pay for petrol, almost £8bn could be raised annually to invest in fighting climate change.
- **Working with the aviation industry** to implement efficiencies that can deliver a step-change reduction in emissions, and where necessary lobbying the European Union for research and development funding. There is much that airlines can do - and are slowly beginning to do - to cut carbon emissions while aircraft are still on the ground and by changing approach paths, amongst other measures.
- **Challenging the need for further runway expansion at UK airports.** While it will be of continued importance for London to have excellent international links, existing runway capacity should be used for business flights and a reasonable volume of leisure flights. Given that the majority of growth has been and will be in additional leisure flights for those who already fly a lot, avoiding runway capacity growth will only affect these incremental, discretionary flights.
- **Educating Londoners and advocating alternatives to air travel** as part of overall communications on climate change and working with the government to develop price-competitive, high-speed rail services.
- **Leading by example** ensuring that all agencies under Mayoral control avoid flights wherever possible and offset their emissions when air travel is the only option.

The Mayoral group

The Mayoral group itself (comprised of City Hall, the London Development Agency, Police and Fire services, Transport for London and Visit London) currently produces around 0.2m tonnes of CO_2 per year. While this is only 0.5 per cent of London's total emissions, the Mayoral group is committed to aggressively tackling CO_2 emissions from its own operations, including the carbon impact of its 75,400 staff, 8,300 vehicles and one million square metres of facilities. In addition, we will seek to demonstrate best practice through flagship projects and catalysing further technological and market developments.

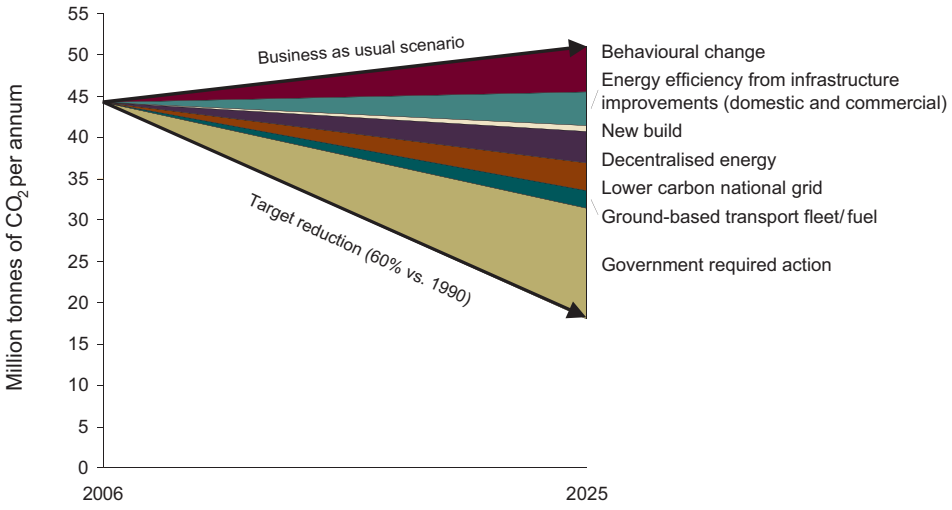
The Mayor's key priorities for action to reduce emissions from the Mayoral Group and demonstrate best practice are:

- **Improving the energy efficiency of our buildings.** This includes installing energy efficient lighting and appliances, and designing new buildings with carbon reduction as the number one priority.
- **Maximising use of decentralised energy** through the installation of combined cooling heat and power (CCHP), micro-wind, photovoltaic (PV) and solar thermal heating at all appropriate GLA group sites.
- **Promoting staff energy-savings behaviour** at home and at work by running ongoing staff campaigns. Savings from changing behaviour in the workplace can be doubled if those changes are mirrored at home.
- **Minimising emissions from travel**, including procuring the lowest-carbon fleet options wherever possible for both operational and support vehicles, reducing non-operational air travel to a minimum and off-setting essential travel.
- **Following high green procurement standards** for contracting all goods and services, and so stimulating market demand for zero and low carbon technologies, products and services. This measure should also help bring the price of the goods down as supply increases.

Meeting the targets

If we achieve the measures set out in this action plan, London will realise a 20 per cent reduction in its emissions by 2016, and so meet the ten-year milestone. However, without further national and international action - most importantly, the introduction of comprehensive carbon pricing - London would only achieve a 30 per cent reduction in 2025 in the best possible case, which is just half the target reduction of 60 per cent. The chart above shows the breakdown of how this would be achieved.

Figure xiii 2025 scenario without required government action



Source London Energy and CO2 Emissions Inventory; GLA

Without concerted action by national government to implement tax and regulatory policies that strongly support CO_2 reductions, London's emissions in 2025 are projected to be 31.4 million tonnes, or 13.4 million tonnes greater than the objective of 18.0 million tonnes.

Unfortunately, when it comes to tackling climate change, quite good is not good enough. It is imperative that we do find ways to meet these targets. Achieving regulatory and fiscal change at a national level will, therefore, be a priority for the Mayor. By demonstrating leadership in London, the Mayor will encourage the government to take the steps necessary to ensure that London and the UK play a leading role in averting catastrophic climate change.

A small number of actions at a national level will be especially significant to delivering substantial carbon emissions reductions in London. The Mayor will therefore particularly be seeking three things from government:

- The rapid introduction of comprehensive carbon pricing across all sectors, including aviation. This is crucial to create incentives for widespread take-up of carbon reduction measures and to drive development of new technologies.
- Regulatory change to incentivise widespread rollout of decentralised energy. This includes simplification of the process for connecting CCHP to the grid, including fair payment for electricity sold into the grid.
- Changes to enable significant reductions in the carbon intensity of the national grid. This includes removing existing planning hurdles to and creating regulatory incentives for large-scale renewables investment, as well as rapid uptake of carbon sequestration while the UK transitions to a more renewable energy based energy supply.

Conclusions

There is no doubt that stabilising London's emissions at 60 per cent below 1990 levels by 2025 and limiting total CO_2 emissions between now and then to 600 million tonnes is extremely challenging. But it can be done, using existing technologies, and will bring real financial and other benefits to householders, businesses and London's economy in general.

This action plan demonstrates that over the next ten years we can put London firmly on the path towards that goal - as long as every part of London's society is willing to play their part.

In the longer term, a new approach will be required at a national and international level, including faster development of low carbon technologies, so that we stabilise emissions at a safe rate.

The Mayor's goal is for London to demonstrate over the next years that a low carbon future is possible and that, indeed, it is the basis for maintaining a great, forward looking and successful world city.

The time for rhetoric on climate change is over. Now the delivery must begin.

The Mayor will report annually on London's carbon emissions and on progress against the targets set out in this action plan.

References

1 This approach has been adopted by the 1992 UN Framework Convention on climate change, which recognises the "common but differentiated responsibilities" of developed and developing nations, and in the Kyoto protocol, where developed country signatories have taken on emissions ceilings under the current phase.

2 UK carbon budget estimated by Tyndall Centre extrapolated to London over the period to 2025. Climate change literature quantifies emissions in both tonnes of carbon dioxide and tonnes of carbon (the later referring to just the elemental carbon component in a molecule carbon dioxide). 600 $MtCO_2$ is equivalent to 165 mega tonnes of carbon. Throughout, this plan quantifies emissions in terms of carbon dioxide.

3 "Commercial and public sector" refers to all commercial, public (including government offices, schools, hospitals), non-governmental and industrial organisations.

4 Defra, November 2006.

5 "London's airports" refers to Heathrow and London City. Gatwick, Stansted and Luton are not included as they are located outside the GLA boundary.

1 Purpose and scope of the Mayor's Climate Change Action Plan

1.1 Purpose

Climate change is the most significant threat to the future development of human civilisation. The purpose of the Mayor's Climate Change Action Plan is to set out an aggressive agenda for London to play its part in averting catastrophic climate change by ambitiously cutting our own carbon dioxide emissions.

Scientists have stated increasingly clearly that only significant CO_2 and other greenhouse gas emissions reductions will work to stop catastrophic climate change (see Chapter 2). This plan aims to create a shared agenda for Londoners and London's public and private sector organisations, and to show how we can achieve these reductions together.

There have been many national and international studies that have considered how catastrophic climate change can be averted. This action plan is underpinned by the most authoritative of these. In particular the Mayor supports the approach outlined by Sir Nicholas Stern in his recent review of 'The Economics of Climate Change' for the UK government. The three essential recommendations of the Stern Review are:

- To establish a carbon price, through tax, trading or regulation.
- To support the development of a range of low-carbon and high-efficiency technologies on an urgent timescale.
- To remove barriers to behavioural change, particularly to encourage the take-up of opportunities for energy efficiency.

Many of the actions required to implement these elements are beyond the Mayor's powers. However, London will work through a range of public and private sector partnerships and international alliances to support CO_2 reductions within and beyond its sphere of control. These relationships are already being established. No one agency, individual, or organisation can solve this complex problem on its own - action from all players is required. This plan therefore highlights not only the action that the Mayor will be taking to reduce the contribution of our own operations, but what would need to happen across London for the required reductions to be delivered.

This plan focuses on the priorities for action in London - that is, those actions that deliver the most significant CO_2 savings at lowest cost (and in many cases with no net cost, since many actions bring energy savings). It sets out where London's CO_2 emissions come from, how they are projected to grow, and what London can do to deliver substantial CO_2 savings while boosting London's economy.

1.2 Scope

This plan covers all CO_2 emitted as a result of London's energy supply and consumption, including the domestic, transport, commercial, municipal, university, school, hospital and industrial sectors. This includes all emissions within the Greater London Authority boundary.

- **CO_2 mitigation.** This document focuses on CO_2 mitigation - that is, reducing emissions - rather than adaptation (responding to the climatic changes that global warming is already bringing). There is a strong connection between the two issues and the Mayor's climate change strategies are being developed in parallel. The Mayor's Draft Climate Change Adaptation Strategy will be published separately in the first half of 2007. The focus of this plan is on CO_2 (not all greenhouse gases), since CO_2 is the dominant greenhouse gas released in London. However, many of the proposed solutions will provide complementary reductions in other harmful pollutants such as particulates and nitrous oxides.

- **Timescales.** This plan focuses on what is required to deliver the CO_2 targets in the proposed draft Further Alterations to the London Plan (described in section 3.3). The Mayor's priorities for action focus on initiatives over the next decade. This plan will be periodically updated, since these initiatives will evolve over time.

- **Waste and water.** Reducing London's volumes of waste processing and water consumption and increasing recycling rates are key environmental priorities but are not explicitly covered by this action plan. However, the CO_2 benefits of producing sustainable low carbon gas energy from waste are significant (up to 4.5 million tonnes of avoided CO_2 per annum, or ~10 per cent of London's current emissions), and are therefore explicitly considered in Chapter 4.4 on Energy Supply. (For further information, please refer to the Mayor's Municipal Waste Management Strategy and Water Action Framework).

- **Indirect emissions.** Since the plan focuses on emissions resulting from activity within London, it does not specifically focus on the opportunities to reduce CO_2 emissions from importing the food and goods consumed in London. Our rough estimates suggest this adds a further 5-10 per cent to London's overall CO_2 footprint; and the Mayor is seeking to reduce this through marketing and behavioural change campaigns which favour buying locally and regionally. The Mayor's Food Strategy lays out some of these issues and a strategy for addressing them.

- **Aviation.** Similarly, while the reduction targets in this plan cover direct aviation emissions in London, i.e. ground-based emissions from airplanes and takeoff/landing cycles, it does not cover total aviation emissions associated with Londoners' air travel. However, given rapidly increasing demand for air travel and the challenges of achieving emissions reductions in this sector, we have nevertheless considered this issue explicitly (but separately) in Chapter 4.6.

The Mayor's detailed strategy and approach towards climate change, including both mitigation and adaptation, will be outlined in a new Mayor's Climate Change Mitigation and Energy Strategy and a Mayor's Climate Change Adaptation Strategy. These will be statutory strategies as provided for in the Greater London Authority Bill that implements the findings of the government's recent review of the Mayor's powers.

The Mayor's Municipal Waste Management Strategy is currently being revised and it, together with the Mayor's Water Strategy will be published in the course of 2007.

2 Introduction: the threat of catastrophic climate change

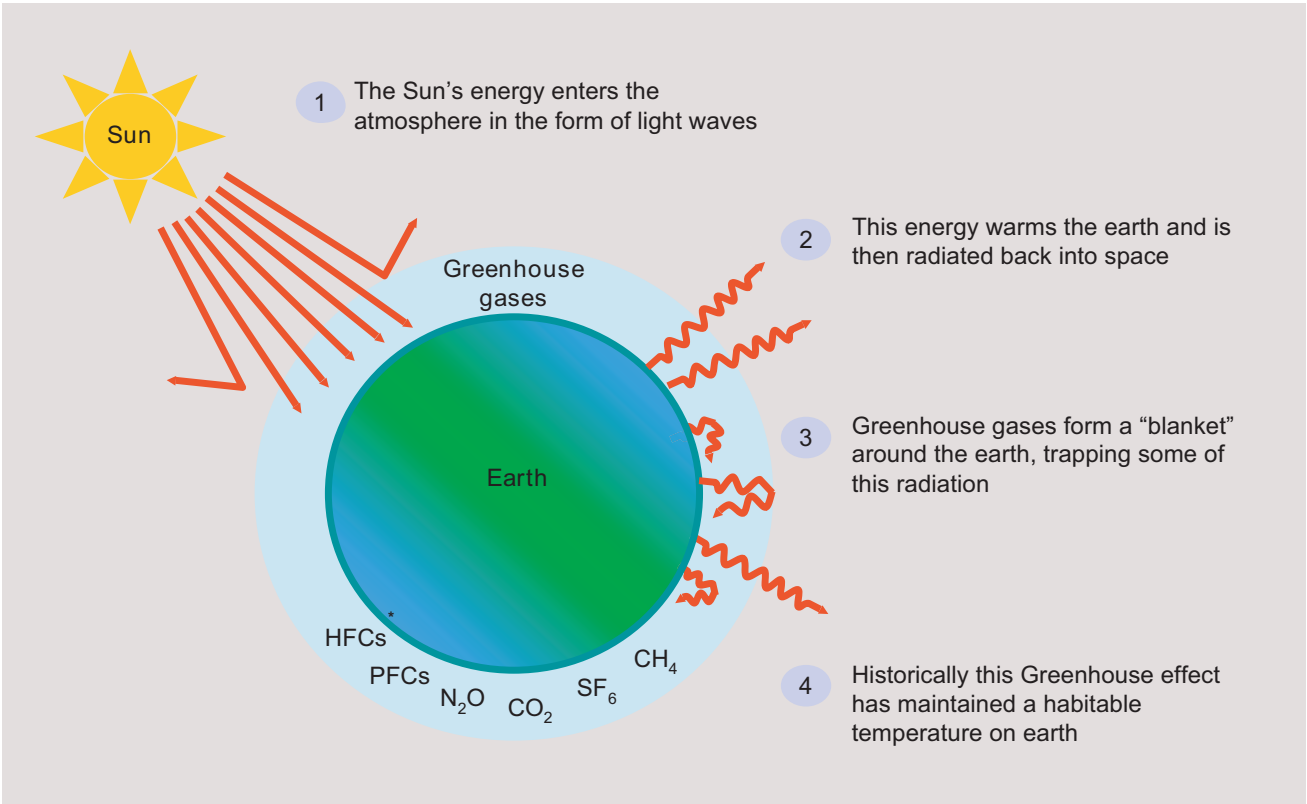
Climate change, also known as global warming or the enhanced greenhouse effect, is caused by the rise in average global temperature due to increasing levels of greenhouse gases in the earth's atmosphere. This in turn causes rises in sea-level, increased surface ocean temperatures and changes to weather patterns. If unchecked, these changes will radically alter our environment and will lead to catastrophic loss of life. There is overwhelming scientific evidence that human activity is the primary cause of this change, and that action is needed within the next 5-10 years to cut emissions to a level that would avoid catastrophic and irreversible climate change.

This chapter provides a brief overview of the scientific evidence documented on climate change and explains why climate changes matters to London.[1]

2.1. Why are temperatures rising?

Greenhouse gases occur naturally in the atmosphere, trapping heat that originates from the sun, but then radiates back from the Earth. Without the natural greenhouse effect the Earth would be over 30 degrees Celcius cooler and uninhabitable.

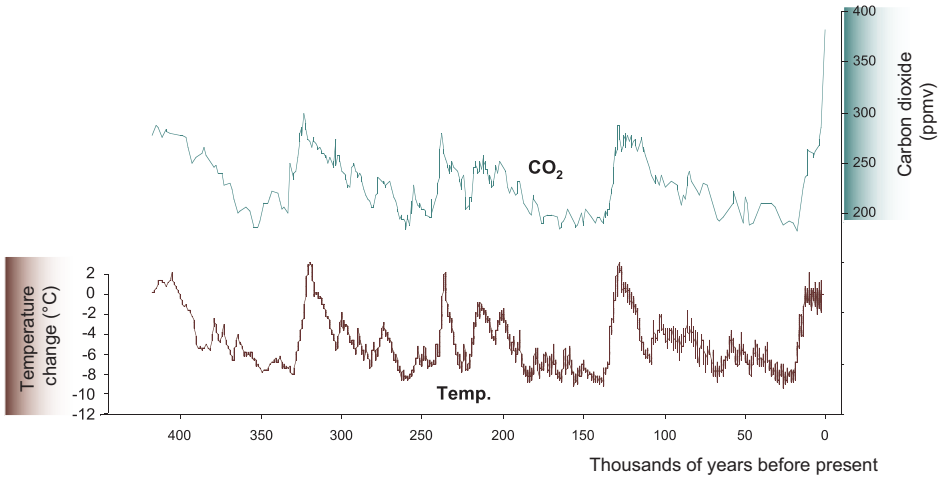
Figure 1 The natural greenhouse effect



However, there is now overwhelming scientific evidence that human activity is upsetting this natural balance, causing a so-called "enhanced" greenhouse effect. The recent Intergovernmental Panel on Climate Change report is unequivocal about the threat of climate change and the direct link between human behaviour and average temperature increases[2]. This report has been agreed by the governments of over 100 countries and by over 2,000 leading scientists. The burning of fossil fuels and land deforestation has altered the balance of sources and sinks of greenhouse gases. This has resulted in rises in the atmospheric levels of greenhouse gases, and resulting increases in atmospheric and surface ocean temperatures. Since 1860, twenty out of the twenty-one hottest years have occurred within the last 25 years; and globally 2005 was the hottest year ever recorded. London has not been immune. Until July 2006, the August 2003 heat-wave was the hottest on record, with 600 Londoners dying prematurely as a result. Across Europe, 32,000 people died because of the heatwave. The latest climate models suggest that the summer of 2003 will be the norm in Europe by the 2040s.

Carbon dioxide is one of six key greenhouse gas types responsible for the enhanced greenhouse effect[3]; carbon dioxide alone contributes approximately two-thirds of the enhanced effect.

Figure 2 CO_2 concentration and temperature over time



Source Redrawn from Fedorov et al, Science, 312, 1485 (2006)

In pre-industrial times, the concentration of CO_2 in the atmosphere was 280 parts per million (ppm). This level has now increased to 380ppm, and is rising every year by 2.2 ppm[4]. Without intervention, prevailing scientific opinion is that levels will rise to over 600 parts per million within the next 45 years with profound and adverse consequences. Worryingly, many scientists predict runaway climate change once 450ppm is exceeded.

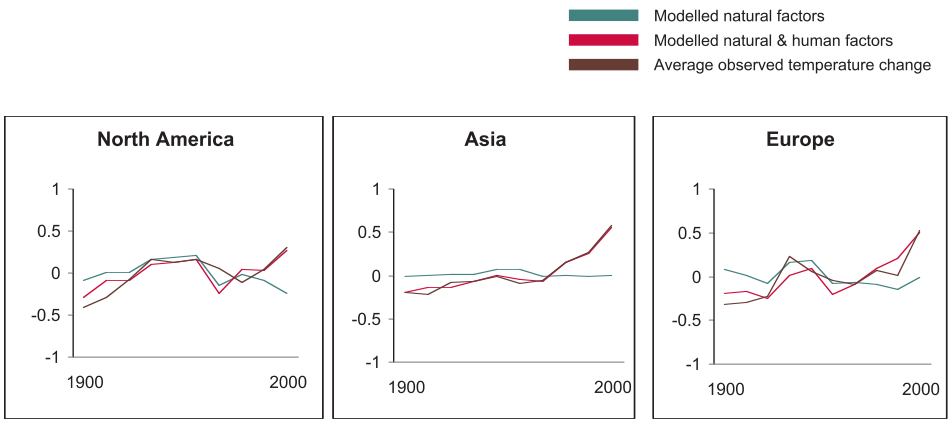
When runaway climate change occurs, it is as a result of feedbacks within the biosphere which release more naturally stored carbon and other greenhouse gases (such as the billions of tonnes of CO_2 and methane currently locked up in perma-frost regions) and the slow-down or failure of ecosystem 'sinks', which currently absorb CO_2 (such as soils and forests). CO_2 stays in the atmosphere for a long time after it is emitted, making the warming effect very difficult to reverse. Currently, it takes about 100 years for CO_2 to be reabsorbed by vegetation and oceans. But if emissions continue to rise at current rates, the system will be overwhelmed and it could take thousands of years for atmospheric CO_2 concentrations to return to current levels.

2.2. Are we sure it's not just natural variability?

Since the Earth's formation 4.5 billion years ago, there has always been a lot of variability both in temperatures in the atmosphere and in the seas, and in levels of atmospheric carbon dioxide. During the last 500 million years, for example, records suggest levels of carbon dioxide have reached as high as 5,000 parts per million. However, these levels predate the emergence of human-beings. Insects and amphibians are thought to have survived in levels of some 3,000 parts per million around 400 million years ago. But humans did not come along until levels had fallen to around 200-300 parts per million.

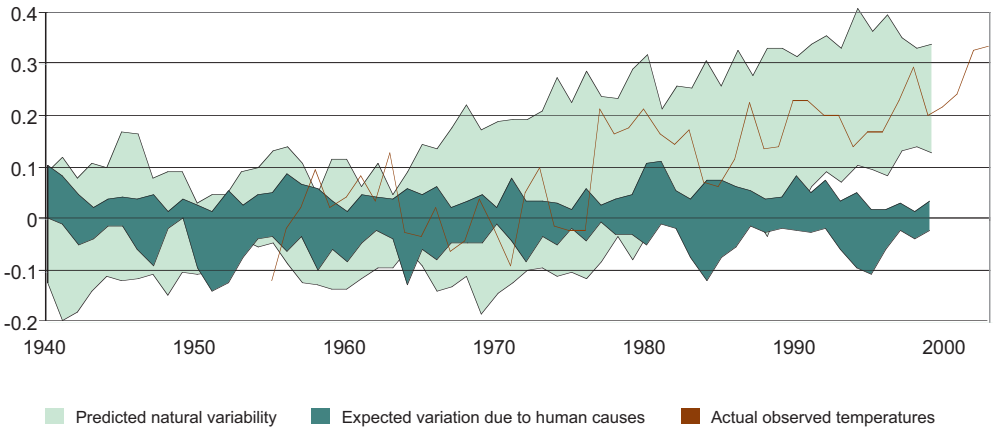
Throughout human existence carbon dioxide levels remained remarkably stable until the industrial revolution 150 years ago. Since then, levels have risen significantly due to human activity, in particular, the extraction and burning of fossil fuels. There is now firm scientific evidence that, as a consequence, the earth's average temperature has begun to increase.

Figure 3 Regional temperature change 1900-2000: Observations and human influences modelled



Source Met Office

Figure 4 Predicted and observed upper-level ocean temperatures 1940-2004



Source Scripps Institution of Oceanography

One of the biggest sources of concern in the scientific community is that warming may set off "feedback loops" that lead to more warming and that we will lose the opportunity to control the pace of change. For example, the Arctic ice-cap reflects back about 50 per cent of the sun's radiation back into space, but as the ice melts due to global warming, its capacity to reflect the sun's rays is reduced and so the process of global warming speeds up. Other feedback loops to worry about include the loss of tropical and boreal forests, the melting of northern perma-frost and the reduced capacity of soils to absorb CO_2.

2.3. Why does climate change matter?

Unchecked climate change will lead to increased global temperatures, rising sea levels and more extreme, unpredictable weather conditions across the globe. These events and their knock-on effects, such as drought and its impact on food production, or the flooding of coastal zones where most people live, will put hundreds of millions of lives at risk. This is already true in the developing world, the citizens of which have done least to cause the problem.

The recent Stern Review, reinforcing the warnings of previous reports of the IPCC, suggested that, without significant action to reduce greenhouse gas emissions, floods from rising sea levels could displace up to 100 million people, disappearing glaciers could cause water shortages for one in six of the world's population, up to 40 per cent of the world's wildlife species could become extinct, and, droughts could create tens or even hundreds of millions of "climate refugees".

Some analysts have previously argued that the costs of climate change are difficult to predict and are insufficient to justify the cost of action to reduce carbon emissions. The Stern Review and other work have now decisively exposed the fallacy of this defeatist argument - the costs of tackling climate change will be far less onerous the sooner we get started. Stern estimated the economic cost of inaction to be in the region of 5-10 per cent of global GDP, versus a one per cent cost to act now[5].

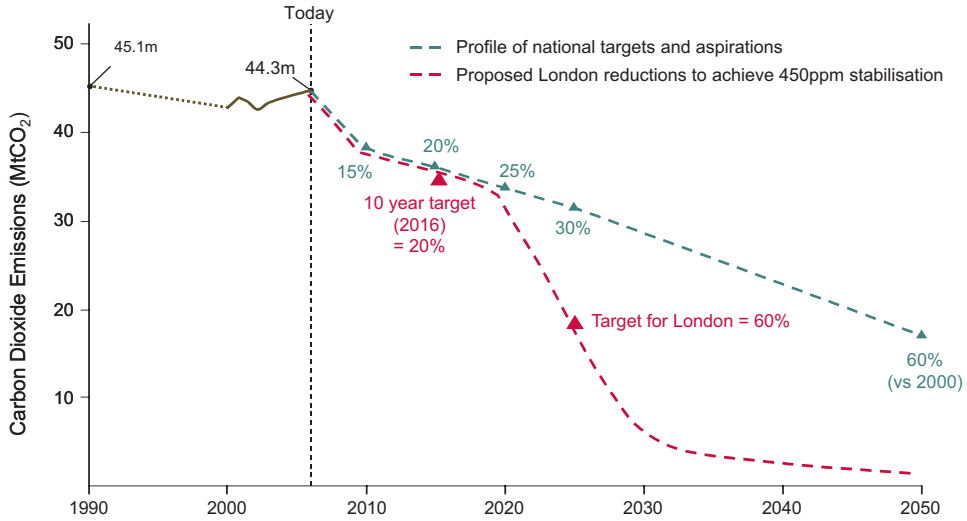
2.4. What do we need to do?

There is general consensus that there is still time to avoid the most catastrophic impacts of climate change, but to do so we must achieve immediate and significant cuts in carbon emissions and stabilise global atmospheric CO_2 equivalent levels at or below 450 parts per million.

This is the prime purpose of the UN Framework Convention on Climate Change, which states in Article 2 that:

"The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabiliation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner."

Figure 5 Keeping temperature increases below +2°C



For the UK to deliver its share of this stabilisation target, recent analysis suggests that a cumulative carbon budget for the UK from 2000 to 2050 of 4.6 gigatonnes of carbon (GtC) must not be exceeded[6]. Managing to stay within this low carbon budget requires significant emissions reduction action to be taken now. We cannot afford to wait for silver bullet technological solutions that may or may not arrive in time (see chapter 3 for more details).

2.5. How are we going to achieve it?

A range of options to cut emissions already exists, but require national and international policy action to motivate take-up and to bring down the costs of implementation. The Stern Review concluded that pursuing three key elements with spending of one per cent of global GDP would enable catastrophic climate change to be averted without capping the aspirations of rich and poor countries. This Action Plan adopts Stern's approach. The three essential elements to pursue comprise:

- **Carbon pricing.** Establishing a price for carbon that captures the full social cost of the production and consumption of carbon, which in turn motivates individuals and businesses to switch away from high-carbon products and services to low-carbon alternatives.
- **Technology policy.** Introducing policies to support the development of a range of low-carbon and high-efficiency technologies on an urgent timescale.
- **Behavioural change.** Removing the barriers to behavioural change, in particular encouraging the uptake of energy efficiency opportunities.

The implementation of such a programme does not require unreasonable self-sacrifice and austerity on the part of individuals. Whilst it is certain that almost every citizen in the wealthier nations of the world is going to have to make changes in their behaviour, a sensible approach to tackling climate change will mean taking actions that foster economic growth and development, and creating opportunities for individuals and businesses. Indeed, recent work has shown that there are considerable growth opportunities in London from the green business sector. In contrast, ignoring climate change will lead to very severe and unwelcome economic and lifestyle consequences.

2.6. Why should London take action?

London must take action on climate change and curb CO_2 emissions for three main reasons.

First, London is already feeling the adverse effects of climate change. The capital is becoming increasingly vulnerable to flooding, subsidence, overheating and to water supply shortfalls. Climate change will increase the probability, frequency and severity of these events through rising sea levels, heavier winter rainfall, higher tidal surges, hotter summers, and less summer rainfall. On top of the environmental and social disturbance these impacts will cause, the economic implications for both individuals and business, such as insurance companies and other financial service providers, are immense. Reports produced by the London Climate Change Partnership describe these impacts in some detail[7]. These negative changes are already starting to be seen, but to avoid them becoming intolerable we need to act now to cut emissions.

Second, even if London could protect its own borders from the worst effects of global warming, as a cosmopolitan world-city, London cannot isolate itself from the severe consequences of climate change elsewhere in the world. Many of London's communities are intimately linked to the vulnerable countries that look set to suffer most. For example, almost 166,000 people of Bangladeshi origin have made their home in London, but their family and friends live in a country where it is estimated that a temperature increase of just one degree centigrade would put 11 per cent of the country under water, displacing and destroying the livelihoods of 55 million people.

Thirdly, London has the opportunity and obligation to provide leadership for other national and international cities. 75 per cent of the world's CO_2 emissions come from cities. Moreover, as the capital of the UK, London represents a country that has profited greatly from fossil-fuelled industrialisation since the 19th century and, along with the rest of Europe, the USA and Japan, is responsible for causing climate change through its energy use. London has a responsibility to take a lead in tackling a problem it played an important part in creating. This does not necessarily mean sacrifices. Major CO_2 savings can be achieved following the good practices of other nations, for example, if the US were able to just match Japan's per capita emissions it would emit three billion tonnes less CO_2 every year.

Since 1850, North America and Europe have produced 70 per cent of all the CO_2 emissions due to energy production, while developing countries have accounted for less than one quarter. That is why the UNFCCC

mandates those countries who have historically been and currently are the worst climate polluters (UNFCC C Annex 1 countries) to be the first to take action to reduce emissions and bear the brunt of cuts in the short-term. But while national governments argue and prevaricate over who should act and by how much, cities like London and city alliances like the C40, can come together and act rapidly and decisively, while international negotiations take longer to make progress.

References

1 For more detail on the science of climate change, please refer to the Intergovernmental Panel on Climate Change (www.ippc.ch), the Tyndall Centre (www.tyndall.ac.uk), the Royal Commission on Environmental Pollution (www.rcep.org.uk), or the recent Stern Review (http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/stern_review_report.cfm).

2 *Climate Change 2007: The Physical Science Basis, Fourth Assessment Report of the intergovernmental Panel on Climate Change* (http://www.ipcc.ch).

3 Other key greenhouse gases covered by the Kyoto Protocol are methane, nitrous oxide, hydrofluorocarbons, perfluorcarbons and sulphur hexafluoride. These are mostly produced through agricultural and industrial processes. Chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) are also powerful greenhouse gases but they are being progressively phased out due to their damaging impact on the ozone layer.

4 Some studies, such as the *Stern Review on the Economics of Climate Change*, refer to the total cumulative impact of the six Kyoto gases in terms of an equivalent concentration of CO_2 (or CO_2e). Actual CO2 concentrations are referred to throughout this report (not CO_2 equivalents) since emissions of the other greenhouse gases are relatively low in London.

5 A summary of the Stern Review: "The Economics of Climate Change" can be downloaded at: www.hm-treasury.gov.uk/media/8AC/F7/Executive_Summary.pdf

6 "Living within a Carbon Budget", Tyndall Centre for Climate Change Research, July 2006 (http://www.tyndall.ac.uk/publications/briefing_notes/Livingwithacarbonbudget.pdf).
4.6 gigatonnes of carbon is equivalent to 16.9 gigatonnes of CO_2.

7 The London Climate Change Partnership has produced a number of reports outlining the potential physical impacts and the financial implications of climate change in London, including *London's warming: The impacts of climate change on London* and *Adapting to Climate Change: Business as Usual?* These reports can be downloaded at: http://www.london.gov.uk/climatechangepartnership/

3 Context: London's carbon footprint and targets for cutting emissions

This chapter provides an overview of:

- London's current CO_2 emissions
- London's growth and projected CO_2 emissions (to 2025)
- London's emissions targets
- What London can do
- What needs to happen to meet the targets

3.1 London's current CO_2 emissions

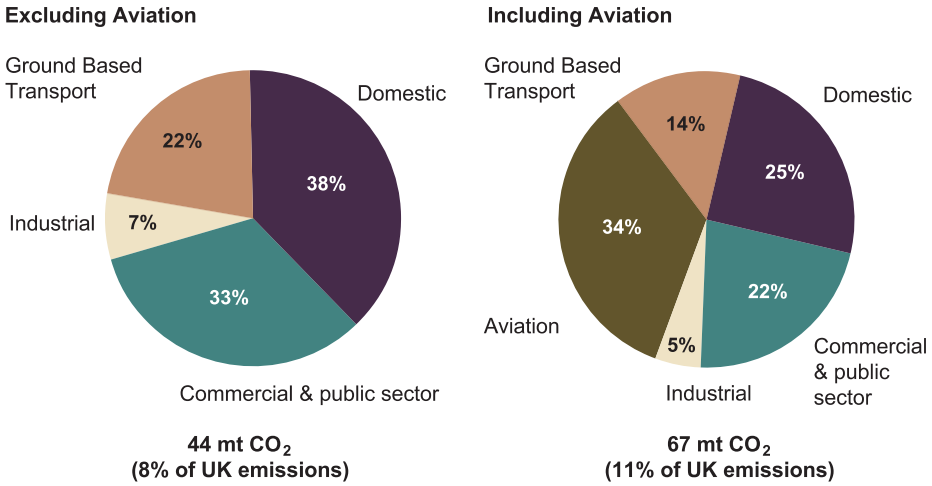
Overview of current emissions

In 2006, London produced 44 million tonnes of CO_2, representing eight per cent of total UK emissions, from the consumption of energy in the domestic, commercial, industrial and ground transport sectors.

The Kyoto Protocol on climate change, which sets legally binding emission reduction targets for national governments, does not include targets on reducing emissions from aviation, as it has not yet been possible to reach agreement among the parties to the treaty. UK government targets also, therefore, exclude emissions from aviation. Carbon emissions from aviation are, however, very real. While they are currently relatively small, they are growing rapidly - more rapidly than in any other sector. If aviation emissions from London airports are included, total emissions from the capital increase to 67 million tonnes of CO_2, or 11 per cent of the UK's emissions[1].

As there are almost no powers available to the Mayor to limit emissions from aviation to and from London, and because national and international agreement is essential to resolve the problem, aviation emissions are not included in the targets referred to throughout the rest of this plan. However, the Mayor intends to use his national and international profile to campaign for global aviation emissions reductions, and Chapter 4.6 explores the challenge posed by aviation and some possible solutions.

Figure 6 2006 carbon dioxide emissions from London



Note 2006 figures are based on latest available LECI data (for 2003) projected to 2006 based on projections for each sector

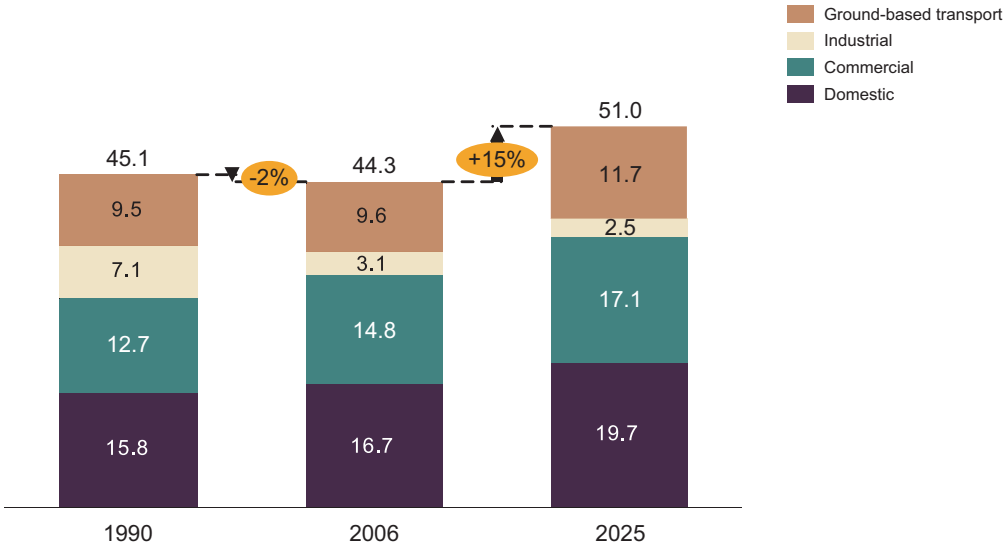
Source London Energy and CO_2 Emissions Inventory; DEFRA

Emissions by sector

Leaving aviation to one side, existing homes are the largest source of CO_2 at nearly 40 per cent of London's emissions, of which three-quarters is from heating. The commercial sector is a close second, but with a larger proportion of emissions from electricity. Industrial emissions are small and shrinking, due to the changing nature of London's economic activity. Transport accounts for under a quarter of emissions, of which nearly half comes from cars.

3.2 London's growth and projected CO_2 emissions (1990-2025)

Figure 7 London's projected CO_2 emissions for 2025 - the business as usual scenario (excluding aviation)
Million tonnes of CO_2



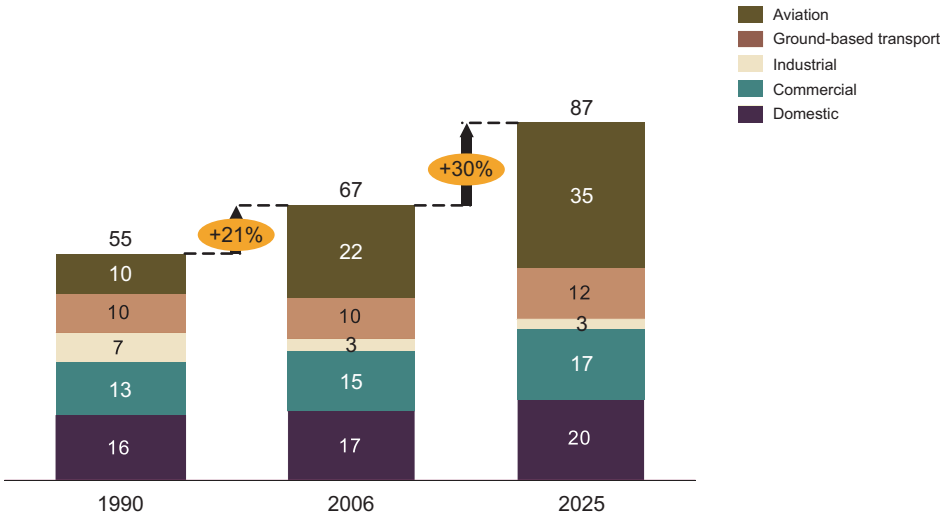
Since 1990

Since 1990, London's overall CO_2 emissions have gone down slightly, from 45 million tonnes per year to 44 million tonnes despite a rise in population of 0.7 million people between 1991 and 2004, and a rise in employment of 0.4 million over the same period. This is due to a halving of industrial emissions, as industrial activity relocates to other parts of the UK or offshore. Transport emissions in London have remained virtually flat (despite a nine per cent increase in kilometres travelled). This is due to high levels of public transport usage and, over the past six years since 2000, strong investment in infrastructure and policies to promote alternatives to the car, including improved public transport and congestion charging.

By 2025

By 2025, given expected growth in London's economy and population, London's CO_2 emissions are projected to increase by 15 per cent to 51 million tonnes[2]. This assumes that there are no major changes from a business as usual approach. All sectors' emissions are projected to increase by 15-30 per cent, with the exception of the industrial sector, which will continue to decline.

Figure 8 London's projected CO_2 emissions for 2025 - the business as usual scenario (including aviation)
Million tonnes of CO_2



Including aviation

By contrast, if aviation emissions attributable to London area airports are included, overall CO_2 emissions have increased by over 20 per cent since 1990. On the basis of current projections of aviation growth, London's total emissions including aviation are set to rise by 30 per cent over the next 20 years. This particular challenge is explored further in Chapter 4.6 on aviation.

3.3 London's emissions targets

Current targets

In the 2004 Energy Strategy, the Mayor adopted for London the government's national targets to reduce carbon emissions by 60 per cent by 2050 (from 1990 levels). To be on course for this, the Mayor's 2006 draft 'Further Alterations to the London Plan' set out the following interim targets:

- 15 per cent reduction from 1990 levels by 2010
- 20 per cent reduction from 1990 levels by 2015
- 25 per cent reduction from 1990 levels by 2020
- 30 per cent reduction from 1990 levels by 2025.

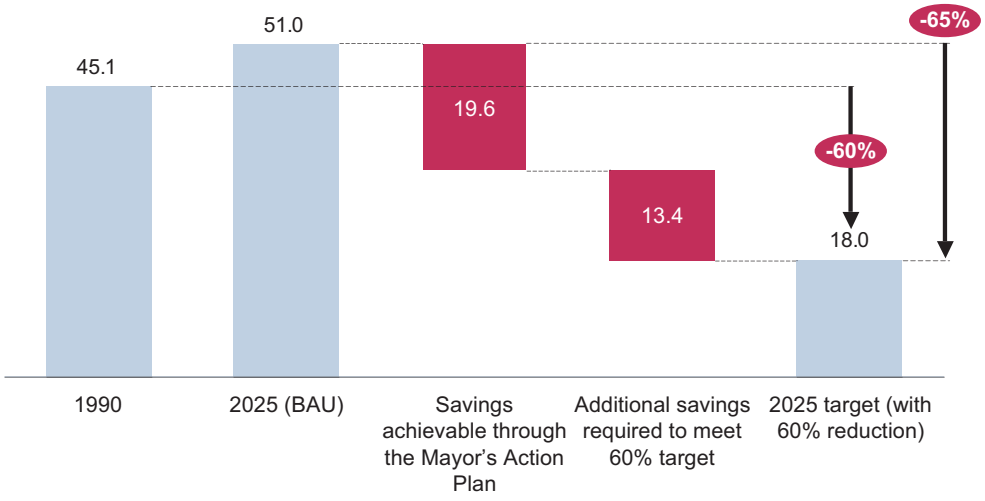
These targets are particularly challenging given London's dramatic growth since 1990, and the continued growth expected to 2025.

New targets

But, it is now clear, as set out in chapter 2, that a 30 per cent reduction in emissions by 2025 will not be sufficient to prevent catastrophic climate change. While the science is still developing, this action plan has taken on board robust evidence from the recent IPCC Fourth Assessment Report, Stern Review and the Tyndall Centre about the need to adopt tougher reduction targets[3].

The Mayor's new target for London, therefore, is to stabilise CO_2 emissions in 2025 at 60 per cent below 1990 levels, with steady progress towards this over the next 20 years. This target is considerably more ambitious than the UK government's current aspiration of a 60 per cent reduction from 2000 levels by 2050.

Figure 9 London's 2025 CO_2 reduction target (excluding aviation)
Million tonnes of CO_2



Source London Energy and CO_2 Emissions Inventory; GLA

The scale of the challenge

To stabilise emissions in 2025 at a level 60 per cent below 1990 levels, London must save 33 million tonnes of CO_2 per annum[4]. This is an enormous challenge and would be substantially greater if aviation were included in the targets.

The difficult truth is that in preparing this action plan we have been unable to present any realistic scenario in which we can achieve the 2025 target set out above, without major national regulatory and policy change.

It is not a question of technology - in all sectors except aviation the technologies we need to deliver this scale of emissions reduction are already available or well on the way to commercialisation.

The problem is that existing taxation and regulation policies do not ensure that carbon emissions are taken into account in setting the price of most products and services. As a result, there are insufficient financial incentives for businesses and individuals to take the kinds of action necessary to cut carbon emissions on the scale that is necessary.

The absolute priority for the Mayor, therefore, is to work with national government to introduce a comprehensive system of carbon pricing. Such a system will catalyse further technological development and commercialisation - and indeed create opportunities for London to host carbon-trading markets, invest in green funds, and research, develop and finance new low-carbon technologies.

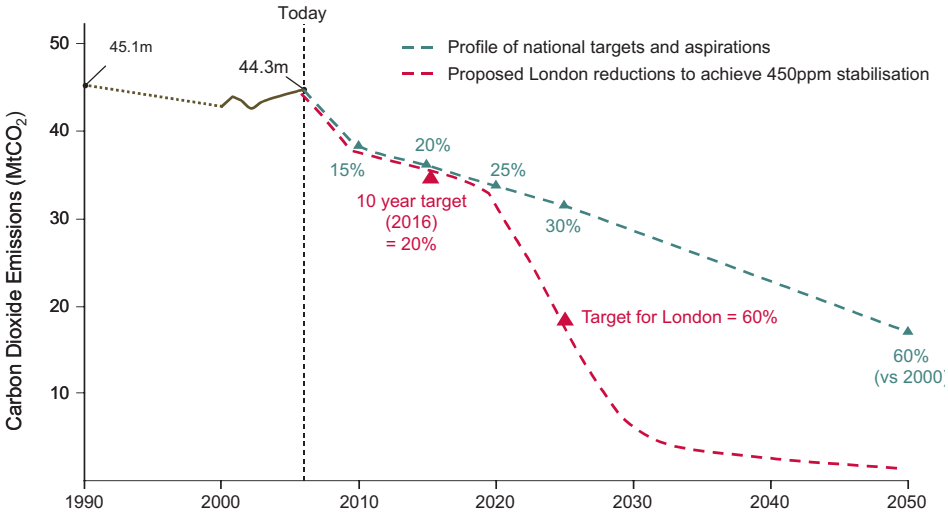
Regardless of what emissions stabilisation target we adopt for 2025, the scale of reduction we would need over the next ten years is about the same. To put it another way, whatever the ultimate goal, we have to get on and immediately start doing all the things that are already cost-effective, obvious and will deliver major emissions reductions right away.

Ten years is also about the longest timeframe over which we can make realistic assumptions about future legislative or technological change. For example, we cannot predict how carbon will be priced in 2020 nor how this might affect the development of zero and low-carbon technologies and products.

This plan, therefore, focuses on what can be achieved over the next ten years, but also considers what sorts of changes will be needed by 2025 and beyond.

The graph below illustrates the core scenarios that this plan has considered. It shows that, by implementing the actions set out in this plan, London can hit its 2016 milestone. However, without much more rigorous national and international action - including introducing widespread carbon pricing - we will divert from this path. By 2025 emissions levels will have stabilised at just 30 per cent below 1990 levels, twice as high as the level required.

Figure 10 Potential London CO_2 trajectories (excluding aviation)



3.4 What London can do?

As stated above, the target of a 60 per cent CO_2 emissions reduction by 2025 is not achievable without national policy change. But significant reductions in emissions can be achieved, particularly over the next ten years. Crucially, many of the initiatives that reduce emissions also reduce costs and therefore produce clear net economic benefits, even before counting in the indirect economic benefits of avoiding the negative impacts of climate change.

The scenario below demonstrates what the Mayor believes London can achieve without national policy change. It has been worked out using realistic assumptions about the willingness of individuals and businesses to reduce emissions without the prompt of carbon pricing. This scenario forms the basis for the detailed chapters on each sector in the rest of the document and would imply almost a 20 per cent reduction by 2016 (meeting the ten year milestone), but only a 30 per cent reduction in 2025 - implying emissions levels double the target. It represents a total achieved saving of 20 million tonnes of CO_2 per year by 2025. This scenario projects:

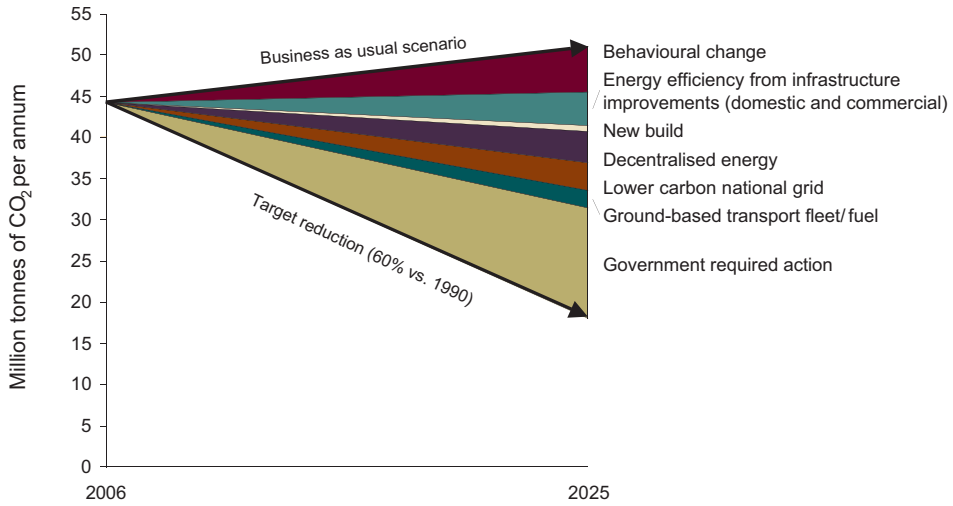
- **Energy supply.** Just over a third of London's identified Combined Cooling Heat and Power potential is put in place, delivering 2.2 million tonnes of CO_2 reductions. More is feasible in principle, but current planning hurdles and the lack of strong economic incentives for energy providers and users unhelpfully restrict CCHP uptake. Even to realise a third of London's CCHP potential will require sustained, coordinated action by boroughs, landlords, utility companies and tenants. Although generating low carbon biogas and syn-gases from biodegradable waste

has huge potential, we estimate that these supply-side energy systems will be slow to roll out given the current dispersed and fractured regime for waste disposal in London and the need for strong measures to pilot and promote the necessary technologies (and so estimated to deliver roughly one million tonnes of CO_2 cuts). Finally, London sees good uptake of micro-generation, which would deliver 0.5 million tonnes of CO_2 savings.

- **Lower-carbon national grid.** Fully half of the savings from London's energy supply come from changes to the national electricity grid. In all scenarios the grid has a dramatic impact on London's emissions - even if there is significant uptake of decentralised energy. Simply by reaching the already-committed national 20 per cent renewables target in the grid, Government can deliver a 3.4m tonne savings to London's emissions[5].
- **Existing homes.** Significant behavioural change due to rising concerns about climate change and ongoing behavioural change campaigns, with over half of Londoners taking simple measures such as switching off lights and turning appliances off standby. Forty per cent of Londoners reduce their heat consumption by 15 per cent through simple home insulation measures. Over 60 per cent uptake of energy-efficient lighting and appliances due to increasing availability, falling prices, and EU legislation promoting these technologies (already emerging).
- **Existing commercial/public activity.** Over half of London's organisations roll out simple operational improvements and staff behavioural change campaigns. Just under half improve thermal efficiency in their buildings, and over half procure energy-efficient lighting and appliances. That is, there is greater uptake of the easier/lower cost measures.
- **New development.** New buildings are designed and built to be 50 per cent more energy and resource efficient than current buildings. But without stronger enforcement by government of national planning and building regimes, the Mayor will only be able to directly determine standards of a very small percentage of new buildings. Therefore only 30 per cent of all new developments are estimated to be built to these standards, achieved through collaboration with boroughs and developers.
- **Transport.** Transport emissions are reduced by 22 per cent from 1990 levels in this scenario. Behavioural change measures such as mode shift and eco-driving account for half of this reduction. Given the Mayor's control of most of London's public transport network, maximum carbon savings are projected across a range of initiatives. The primary hurdle to further reductions is the low uptake of low-carbon freight vehicles and cars. Since freight and cars account for 75 per cent of transport emissions, this is a key gap in delivering reductions - a gap which much greater carbon-based pricing incentives would need to fill.

Figure 11 2025 scenario without required government action

Source London Energy and CO_2 Emissions Inventory; GLA



By sector

In aggregate, the domestic sector delivers 7.7 million tonnes of the reduction, the commercial sector delivers 7.6 million tonnes, and the transport sector delivers 4.3 million tonnes.[6] In other words, savings are roughly proportionate to each sector's contribution to overall emissions today.

By policy type

Demand-side measures to reduce energy consumption deliver over half of the total savings in this scenario. Simple no-cost/low-cost behavioural change measures alone can deliver over half of this amount. Improvements to the carbon-intensity of London's energy supply deliver nearly half the total reduction at eight million tonnes, while new build delivers less than one million tonnes.

Assessment of the scenario

A key point to emphasise is that it is possible to achieve - and exceed - these reductions on the basis of existing technologies. Of course, further technological advances will facilitate further reductions and are critical in the long-term, but the absence of radical new technologies should not be seen as a reason to delay action.

This scenario assumes strong contributions from voluntary changes in existing home and commercial energy use, with penetration rates of 40 to 60 per cent. This kind of uptake would deliver substantial benefits both to lowering London's carbon footprint and in energy bill reductions for Londoners and London's public, private and voluntary organisations. However, this scale of change is pushing the boundaries of what can be achieved without stronger pricing incentives.

It should be noted that individuals and organisations in London may be less able or prepared to make these changes than projected. Generally, social and behavioural change programmes can deliver change in about 20 per cent of the population through voluntary measures. Greater uptake typically requires pricing measures or mandate. If only 20 per cent penetration is achieved, three million tonnes of savings are lost. This gap could be easily closed by government action in just one of a number of areas, including:

- the introduction of pricing mechanisms that incentivise uptake of energy efficiency and/or decentralised energy, including attractive rates for selling electricity back to the grid, or
- doubling the national grid renewables target, or
- implementation of some carbon sequestration for national power plants as a way to further reduce national grid emissions while the UK achieves a transition to a renewable energy based economy.

3.5 What needs to happen to meet the 60 per cent target

The projected failure of London to meet the ambitious 60 per cent reduction target by 2025 in our scenarios is not due to lack of will or technological barriers. It is due fundamentally because the cost of emitting carbon is not factored into the price of products and services in the UK or internationally. In economic terms, the emission of greenhouse gases is treated as an 'externality'. That is, those who produce greenhouse gases through what that sell or consume do not have to pay for the costs that they are imposing on current and future generations by causing climate change.

As the recent 'Stern Review' of the economics of climate change correctly pointed out, climate change is thus probably the biggest-ever example of market failure.

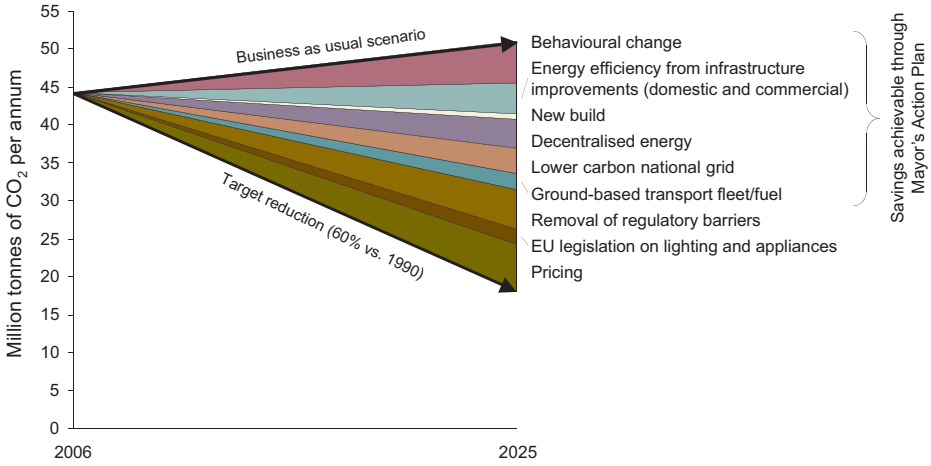
To correct this, a price for carbon must be established through taxation, trading and regulation. As the Stern Review argues: "This will lead individuals and businesses to switch away from high-carbon goods and services, and to invest in low-carbon alternatives. Economic efficiency

points to the advantages of a common global carbon price: emissions reductions will then take place wherever they are cheapest."[7]

While the Mayor will be able to make some contribution to the development of a carbon pricing system in the UK, for example through measures such as a new emissions-based congestion charge in central London, clearly this requires national and international action. It will therefore be a high priority for the Mayor to work with government, business and others to introduce such a national system.

It would be foolish to try and predict what the response would be if a system of carbon pricing were introduced. Part of its benefit would be to drive innovation in no-doubt-unexpected directions. The section below sets out the type of reductions that could be possible if a comprehensive carbon pricing system and other supportive national policy measures were adopted. Once implemented, they would very likely achieve the tougher 60 per cent emissions reduction targets that the Mayor now considers necessary.

Figure 12 London's path to the 60 per cent reduction target (excluding aviation)



Source London Energy and CO_2 Emissions Inventory; GLA

Additional measures to reach the 60 per cent CO_2 reduction target by 2025 include:

- **Greater demand-side energy efficiency measures** in both the domestic and commercial/public sectors (3.6 million tonnes of further CO_2 savings).
- **Doubling penetration of decentralised energy and energy from waste** in London. Due to a combination of pricing incentives and

removal of current statutory barriers. In the case of decentralised energy, enabling the sale of locally produced electricity into the grid at attractive prices (as is currently done in countries such as Germany) is a key element. Changes to create incentives within the regulatory structure for utilities would also lead to greater CCHP penetration. Pricing incentives will have a particular effect in catalysing the development of technologies and supply systems where biofuel and synthetic gas energy is generated from biodegradable waste streams (3.7 million tonnes of further CO_2 savings).

- **Fifty per cent reduction in the carbon intensity of the national grid** through greater use of large-scale renewables and carbon sequestration. This requires regulatory and fiscal changes, as well as the removal of current planning barriers to large-scale renewables implementation (2.2 million tonnes of further CO_2 savings).

A number of less significant measures (in CO_2 reduction terms) will also contribute to the 60 per cent target:

- **Required energy efficiency standards for commercial buildings,** through expansion of the European Performance of Buildings Directive (0.8 million tonnes of further CO_2 savings).
- **Much improved enforcement of government planning and building regulations** on energy efficiency of new buildings (delivers an additional 1.1 million tonnes).
- **EU action to mandate energy-efficient lighting and appliances,** leading to a full phasing-out of traditional, energy-intensive lighting and appliances (delivers a further 1.7 million tonnes of savings).
- **EU level accreditation scheme for biofuels,** together with the necessary technology developments to make biofuels more widely available (delivers 0.3 million tonnes of additional CO_2 savings).

60 per cent: by sector

In the 60 per cent reduction scenario, the domestic sector would deliver 12m tonnes of CO_2 savings, the commercial/public sector 14m tonnes, and the transport sector 7m tonnes. As in the 30 per cent case, savings are roughly proportionate to current sector emissions contributions.

60 per cent: by policy type

Together, demand-side reductions from behavioural change, operating changes and physical improvements to deliver energy efficiency are the biggest source of reductions at 16 million tonnes (of which nearly half do not require any significant changes to physical infrastructure). Lower-carbon energy supply is a close second at 15 million tonnes, largely from greater penetration of decentralised energy and changes to the national

grid. New build is still the smallest contributor but delivers substantially more than in the 30 per cent case, at two million tonnes.

Assessment of the 60 per cent scenario

This is just one scenario and increased savings in one area could clearly balance savings that prove difficult to achieve in another. But it is clear that achieving these larger reductions will only happen with carbon pricing and the removal of legislative barriers to behavioural and technological change.

In pursuit of this more challenging - and more important - target, the Mayor will work with national and international government and alliances to achieve a new framework. In particular, the Mayor will be pushing for:

- The establishment of London as the global centre for carbon trading, with carbon priced at a level that reflects its true environmental and social cost. This will provide economic incentives across all sectors, and accelerate the development and commercialisation and uptake of new technologies.
- The introduction of personal carbon allowances covering all aspects of individual energy consumption, to drive savings from behavioural change and energy efficiency.
- Removing barriers to much lower-carbon energy supply, such as the role of large-scale renewables, decentralised energy and the utilisation of waste heat.

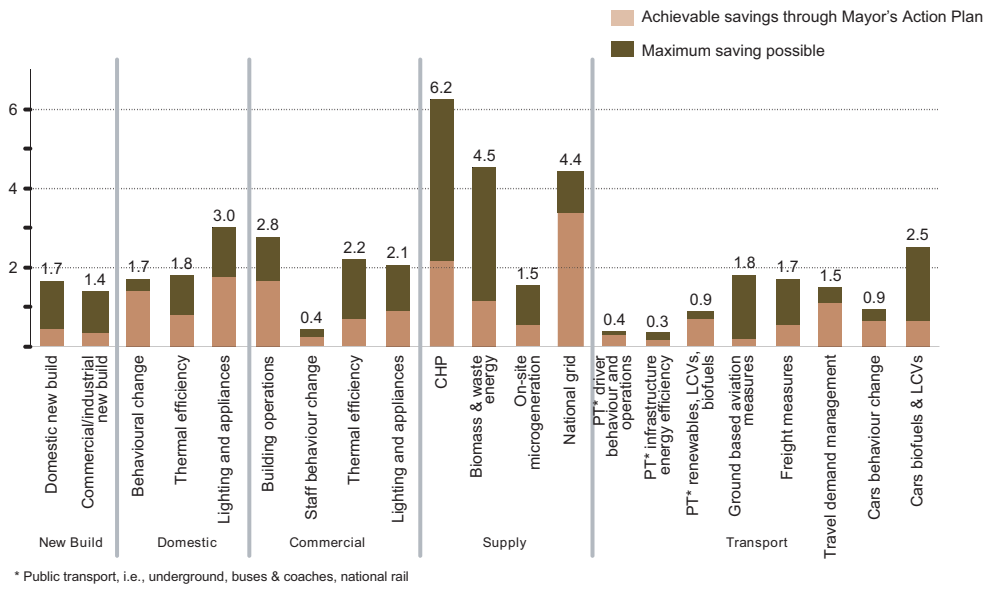
Action plan approach

The approach taken in this action plan has been to set out a programme that the Mayor is confident can be delivered in London and which prioritises those initiatives that will achieve the greatest carbon emissions reductions most quickly and most cost-effectively. If delivered, this programme will mean that London is on course to achieve science-based emission reduction targets, but additional action by government and others will be necessary if this momentum is to be maintained through to 2025 and beyond.

Remaining sections

The subsequent chapters in this document provide a detailed review of each of the key sectors in London and the priority actions identified by the Mayor to put London on the path to delivering these carbon dioxide savings. They set out both the context and rationale for each action, and provide detail on how the actions will be pursued.

Figure 13 Savings for each measure, showing the 60 per cent target, and the savings currently achievable in London
Million tonnes of CO_2



Note PT refers to public transport (i.e., underground, buses and coaches, national rail)

Who can deliver the reductions

Under all scenarios considered in this action plan, the Mayor and the GLA alone cannot deliver more than 15 per cent of the necessary reductions. Responsibility for tackling climate change must be shared between the Mayor, the London boroughs (5-10 per cent of requirement), London's companies and public sector organisations (35-40 per cent), Londoners (5-10 per cent) and national government (30 per cent).

- **The Mayor** will work with Londoners and London's public, private and voluntary sector organisations to promote behavioural and other changes across the board. The GLA will lead the way through best practice, promoting high standards for new build, and lobbying government and the EU for legislative changes that will make emissions reductions easier to achieve in London.
- **London's boroughs** should (as many are already doing) work with their residents and businesses across all aspects of energy use. London's councils are major employers and building owners, and also have a key housing role. In particular, borough-planning departments play the central role in delivering better standards for new developments in London. The boroughs are also key to promoting and facilitating the uptake of decentralised energy sources such as CCHP, and new lower-carbon fuel sources such as biofuels from waste.

- **London's companies and public and voluntary sector organisations** can save on their energy bills and reduce their own emissions through measures such as staff behavioural change campaigns, improvements to building and vehicle operations, and moving to low-carbon decentralised energy sources. They will also be a critical link to providing the products and services that will enable individuals to reduce their emissions; indeed, this represents a significant opportunity for London's economy.
- **Londoners** may be surprised at the scale of the contribution they can make through even simple personal decisions. Changing one's energy consumption behaviour at home and at work doesn't cost anything, but make a real impact on emissions. More substantial measures, such as improving the thermal efficiency of homes and buying lower-carbon vehicles when buying a new car, require upfront investment, but will deliver a quick payback since they typically deliver substantial energy savings. For example, traditional light bulbs waste most of their energy by turning it into heat. Energy saving bulbs last, on average, up to 12 times longer than ordinary light bulbs and use 75-80 per cent less electricity. Each one can save up to £100 over the lifetime of the bulb.
- **Government** has an absolutely critical role to play in and must rapidly adopt a national approach to carbon pricing (as recommended by the government's Stern Review, see below) to provide fiscal and other incentives for energy efficiency and the development of new, lower-carbon technologies. Government also has a crucial enabling role in specific areas such as improving the enforcement of planning/building regulations, removing planning barriers to decentralised energy and large-scale renewables, decreasing the carbon intensity of the grid mix.

The time for rhetoric on climate change is over. Now the delivery must begin.

References

1 Allocation done on the basis that emissions associated with Heathrow and City airports allocated to London on a share of UK passenger kilometres basis.

2 Growth projections are detailed in chapter 1 of the draft further alterations to the London Plan (http://www.london.gov.uk/mayor/strategies/sds/further-alts/docs.jsp).

3 Stern Review highlights 450ppm CO_2e as a potential stabilisation target (www.hm-treasury.gov.uk); whereas the Tyndall Centre's "Living within a Carbon Budget" suggests 450ppm CO_2 as the maximum targeted

atmospheric concentration. To achieve this, it estimates that CO_2 emissions from all sectors (including aviation and shipping) would have to reduce by 90 per cent by 2050 and by about 70 per cent by 2030 (http://www.tyndall.ac.uk/publications/briefing_notes/Livingwithacarbonbudget.pdf).

4 Compared to the "Business as Usual" projection.

5 Currently the government is behind in reaching the renewables target, with year-on-year progress lagging behind by about half expected levels.

6 In adding up to a sector level, the domestic and commercial sectors include new developments and changes to the carbon intensity of the energy supply (both allocated out to each sectors).

7 Stern Review on the economics of climate change.

4 Actions: tackling London's CO_2 emissions by sector

Overview

This chapter lays out where London's CO_2 emissions come from, how they are projected to grow, and how London can deliver substantial CO_2 savings, looking at each of the six key sectors in turn:

- Existing homes
- Existing commercial and municipal activity
- New buildings and development
- Energy supply
- Ground Transport
- Aviation.

Each chapter is structured as follows:

- Current and projected emissions from the sector, including CO_2 reduction targets and an overview of key actions required to deliver the target
- Specific features of the sector
- Summary of potential actions to reduce CO_2 from the sector
- Actions already underway to tackle emissions from the sector
- The Mayor's key priorities for action for the sector.

4.1 Emissions from existing homes

4.1.1 Overview

The main source of CO_2 emissions in London is energy use in existing homes. Excluding aviation, the domestic sector contributes nearly 40 per cent of total London emissions. This includes gas for cooking and heating as well as electricity for lights and appliances.

In the medium to long term, reducing the carbon intensity of the energy supplied to these homes will be a key element in reducing domestic emissions; as is ensuring that new homes are built so as to minimise energy consumption (and hence energy bills) for their new occupants. But the biggest immediate priority is to enable the lower consumption of energy in existing homes.

Londoners can still do everything they want and need to do at home - staying warm, watching TV, cooking, etc. You don't have to reduce your quality of life to tackle climate change, but you do have to change the way you live. That means wasting less energy, but it also means a significant reduction in energy bills - a cut of roughly 30 per cent[1]. Considering that average energy bills have increased by 60 per cent for electricity and nearly 100 per cent for gas in the last three years, achieving these reductions becomes increasingly significant for everyone - and particularly for lower-income groups. Critically, these carbon-reducing energy efficiency measures will improve quality of life at a relatively small up-front cost.

Of all the options considered in this plan, it is helping individual Londoners to reduce their own carbon footprint that offers the greatest opportunities to cut emissions quickly, cost effectively and with significant additional benefits. How we can deliver substantial reductions in energy consumption includes:

- Simple, cost-free actions to cut out wasteful energy use (for example, turning off lights when we leave rooms, washing clothes at 30°C not 40°C).
- Reducing necessary electricity use by increasing the take-up of energy efficient lightbulbs and appliances.
- Reducing energy used for heating and cooling by improving the thermal efficiency of homes.

Individual homeowners will play a critical role in deciding to adopt these measures, but there are a wide range of players who the Mayor will work with to enable homeowners to achieve these energy and cost savings.

These include estate agents, mortgage lenders, landlords, housing associations, and building supply retailers and wholesalers - to name just a few. There are also currently several sources of advice for homeowners on reducing carbon emissions, such as the Energy Savings Trust's Energy Efficiency Advice Centres, and a range of national and local websites from public, private and voluntary sector organisations. The Mayor will work to better coordinate these various sources of advice and make the right information available to Londoners in the most appropriate way.

The rest of this chapter covers:

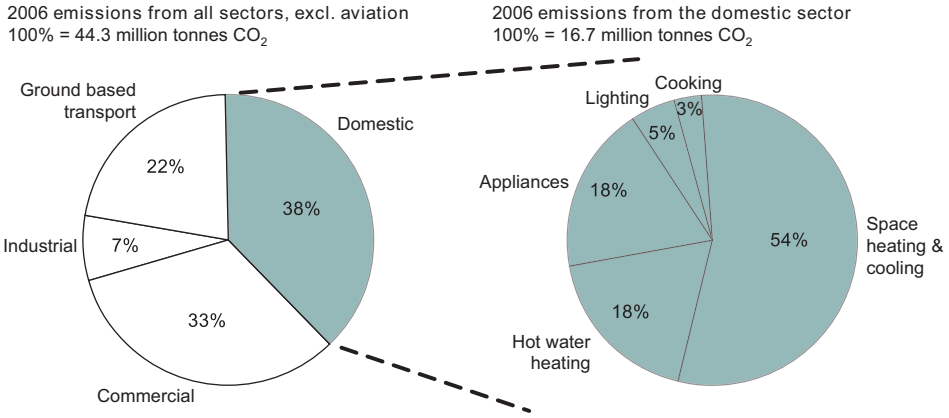
- current and projected emissions from London's homes, including CO_2 reduction targets and an overview of key actions required to deliver the target
- specific features of the London housing market
- a summary of potential actions to make homes more energy efficient, including current penetration of energy efficiency measures in London and barriers to further take-up
- actions already underway to tackle emissions from London's homes
- the Mayor's key priorities for action, with indicative CO_2 impact and cost for each.

4.1.2 Current and projected CO_2 emissions from London's homes

Current emissions

London's 3.1 million homes account for 16.7 million tonnes of CO_2, or nearly 40 per cent of London's total CO_2 emissions. Fully three quarters of domestic emissions come from space and water heating. London's domestic CO_2 emissions from 1990 to 2006 increased by six per cent because of rapid population growth and an increase in the number of households, as well as an increase in energy used per dwelling of 0.1 per cent each year[2].

Figure 14 2006 CO_2 emissions from London's domestic sector



Note Cooling in the domestic sector represents a small component, currently at <1 per cent, although this is expected to grow as summer temperatures rise

Source LECI; DEFRA

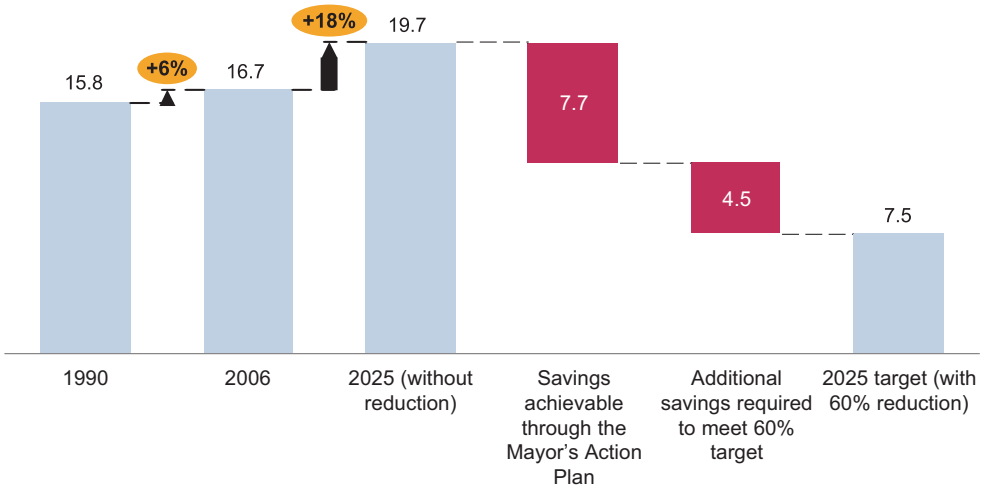
Future emissions (2025)

Without intervention, CO_2 emissions from London's homes are projected to rise to 19.7 million tonnes per annum by 2025 (an increase of 18 per cent), driven by projected growth in both the number of dwellings and in net energy consumption per capita.[3]

Sectoral target

Taking the target of a 60 per cent reduction from the 1990 baseline, to be achieved by 2025, the domestic sector would need to emit 12.2 million tonnes less CO_2 p.a. by 2025 (including savings from a reduced carbon energy supply and more energy efficient new building). Achieving this reduction will be extremely challenging, and realistically requires the establishment of a UK carbon pricing system. However, in the current policy environment, a saving of 7.7 million tonnes is achievable by 2025 (including savings from supply and new builds).

Figure 15 Domestic - comparison of 2025 CO_2 emissions with and without 60 per cent reduction
Million tonnes of CO_2



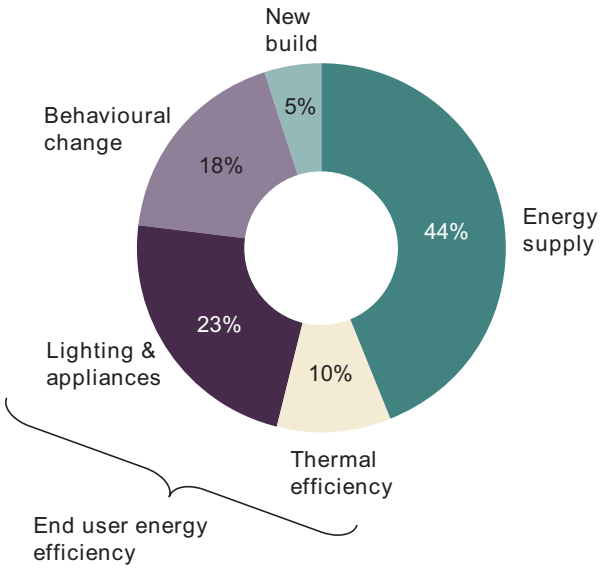
Overview of how savings can be achieved

Saving 7.7 million tonnes could be achieved through a range of measures[4]:

- A 20 per cent reduction in energy consumption of existing households is achievable, through:
  - 70 per cent improvement in energy efficiency from lightbulbs and appliances in 70 per cent of households
  - 10 per cent reduction from simple changes in behaviour in 60 per cent of London households (eg, switching off lights, turning down thermostats)
  - 15 per cent increase in thermal efficiency in 40 per cent of London households
- More broadly, carbon reductions can be achieved through a ~20 per cent reduction in the carbon intensity of the energy supply to all houses; and capturing ~30 per cent of the potential new build CO_2 savings, saving 0.4 million tonnes of CO_2

New build and supply-related savings are addressed separately in Chapters 4.3 and 4.4.

Figure 16 Sources of savings in the domestic sector versus 2025 business as usual scenario



4.1.3 Specific features of the London housing market

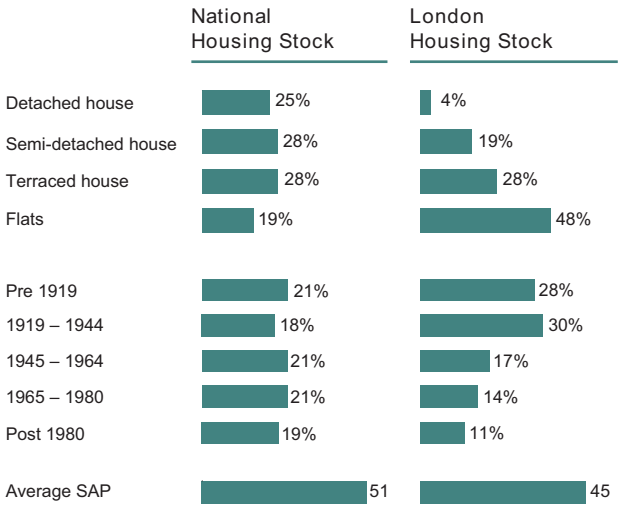
The energy efficiency of London's homes is in part driven by the nature of London's housing stock; this also influences the type of energy efficiency measures that can be implemented.

Age and type of homes

London's housing stock differs from the average national housing stock:

- It is older than the UK average: 60 per cent of London's housing stock was built before 1945, compared to 40 per cent nationally. As a consequence, London's housing stock is less energy efficient than the UK average (London's average SAP rating is 45[5], versus a national average of 51), so there is significant opportunity to improve home energy efficiency in London. But, conversely, certain measures are not appropriate for older buildings (particularly cavity wall insulation since older buildings do not have cavity walls; and double/triple glazing in some cases where buildings have listed status).
- Nearly half London's housing stock is flats in multiple-occupancy buildings; this means a reduced opportunity for loft insulation compared to the national average.

Figure 17 Age and energy efficiency of London's housing stock compared to UK average



Source 2002 London Household Survey; English House Condition Survey 2001

Some categories of housing are responsible for large amounts of London's CO_2 emissions, particularly older and larger properties. However, it should be noted that some categories emit a lot of CO_2 because there are a lot of similar houses in London. On a per-house basis, carbon reduction is achievable from all houses, as will be explained later in this chapter.

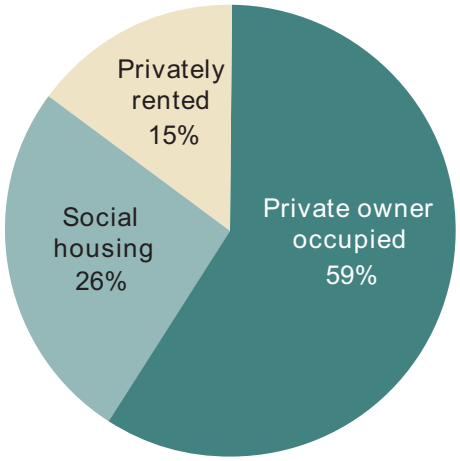
Types of ownership

London's homes fall into three broad categories of ownership:

- **Private owner occupied** is the largest sector at 59 per cent. Here individual homeowners are the main decision-makers on reducing energy consumption, but players in the property industry are also key to facilitating and incentivising these changes.
- **Privately rented** is the smallest sector at 15 per cent. While tenants can get savings from behavioural changes (like turning appliances off standby or switching to energy efficient lightbulbs), driving thermal efficiency improvements in this sector is difficult, as landlords need to take action that does not directly benefit them.
- **Social housing** comprises 26 per cent of homes. These are owned and managed through a number of different structures including Housing Associations, arms length management organisations (ALMOs) and boroughs. Following the passage of the Greater London Authority Bill, the Mayor will have increased powers in the housing sector. An important objective in using these powers will be to deliver energy

efficiency improvements in social housing (for example, as part of refurbishments), with the twin aims of reducing carbon emissions and cutting energy bills for those in social housing.

Figure 18 Categories of ownership for London's housing



Source DEFRA; GLA analysis

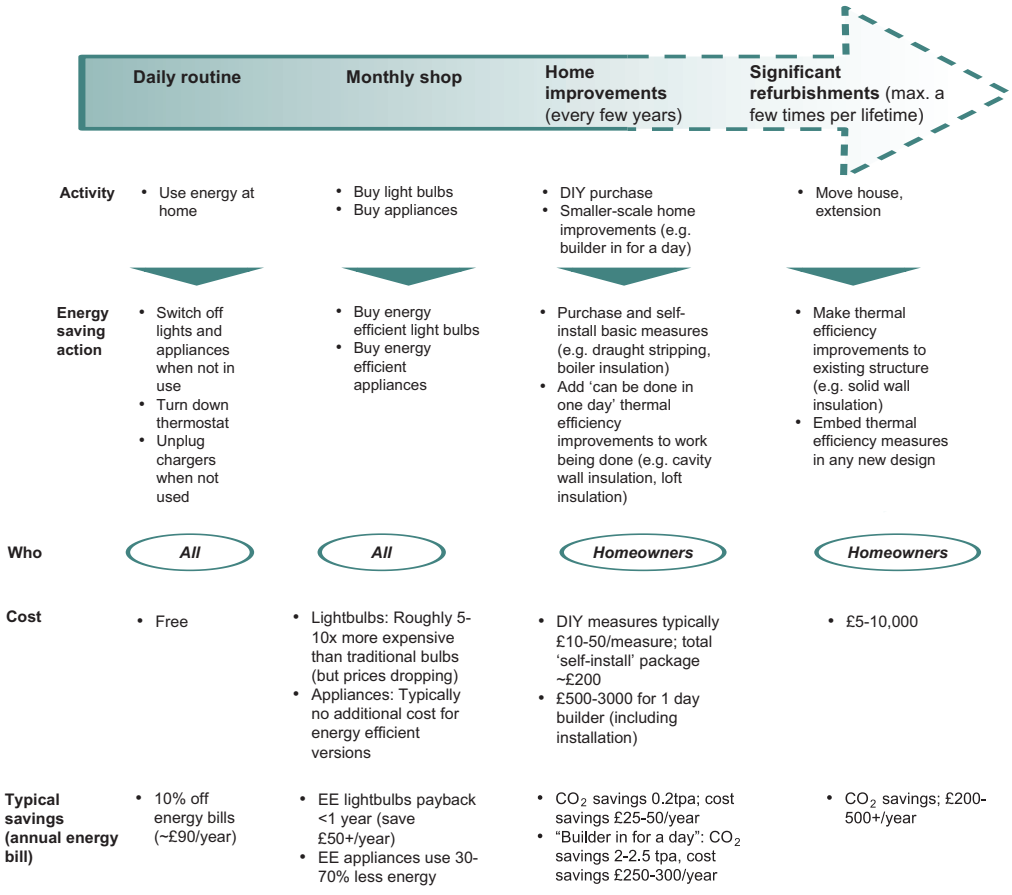
It is possible for all Londoners to achieve energy savings from behavioural changes and to a certain extent from energy-efficient lighting and appliances. For tenants in rented accommodation, landlords will be critical to delivering energy efficiency improvements. However, at the moment, many private landlords are not prepared to make investments in energy efficiency. The common view is that these do not translate into rental premiums - and so landlords are reluctant to make the investments that would benefit their tenants.

4.1.4 Summary of potential actions to make homes more energy efficient

No matter what the age, type, or ownership of a dwelling, there are significant opportunities for improving energy efficiency in the home. Delivering these improvements will require three steps: individuals deciding to take action; the building design and construction industries responding to that demand; and, the government providing the advice and incentives to encourage action.

Efforts to persuade individuals to adopt energy efficient behaviours and make investments that will deliver energy savings will be most successful and efficient if they are targeted at those times when people are making life-style decisions - such as refurbishing or moving home, purchasing appliances or going to a DIY retailer. For example, over the next 50 years, most central heating and appliances will be replaced at least three times, and the majority of people will move house several times.

Figure 19 Key decision-making points, costs and benefits for energy savings

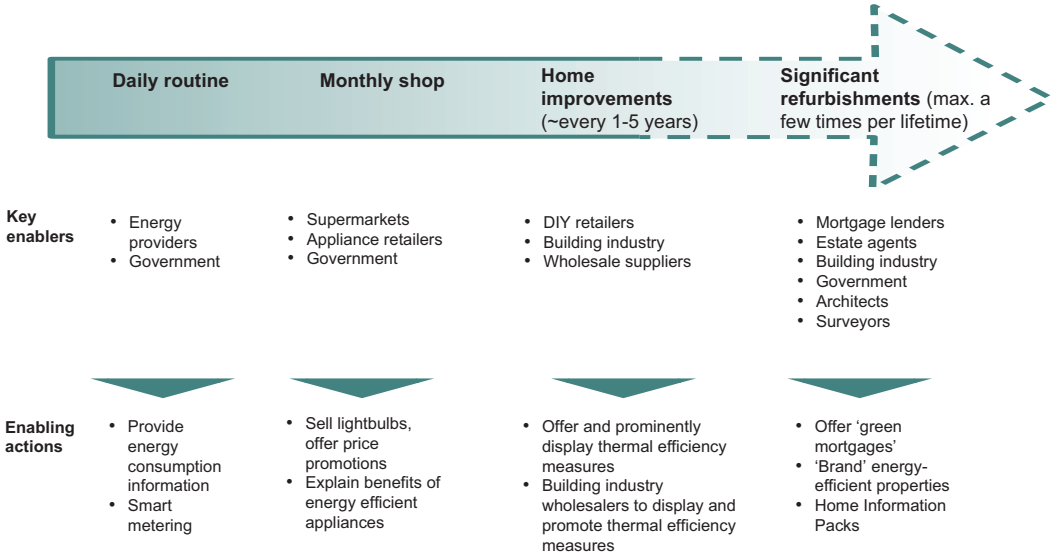


Across all these decision points, barriers currently exist to individuals saving energy or investing in cleaner forms of fuel and power. These typically include:

- **Lack of awareness:** "I didn't know there was something I could do"; "I don't know whether doing this will have any impact".
- **Perceived or actual cost:** "I would do it, but it's too expensive"; "I didn't know it made such a difference in reducing my energy bill".
- **Availability/ access**: "I know what I need to do but I don't know who to call or where to go to buy it"; "there isn't anyone who can help me install it".

The supply chain, supported by government, also has a role to play in encouraging actions that reduce energy emissions in the domestic sector. Different players will be crucial to enabling these behavioural and lifestyle changes, as indicated below.

Figure 20 Role of the market and supply chain



The next section looks at each of the three key domestic energy savings opportunities in turn: behavioural change; buying energy efficient light bulbs and appliances; and, putting thermal efficiency measures in place.

a "Daily routine"

Small changes. The simplest measure we can take - which is remarkably effective - is changing how we use heat and electricity to avoid waste. This includes making sure we are not overheating our homes, turning off lights and unplugging chargers when not in use, and not leaving TVs and other appliances on standby[6]. These actions are cost-free and typically will result in annual energy savings of £90 (~10 per cent) per household. This would mean total savings of over £250 million if all Londoners adopted these behaviours.

Smart metering. These changes can be facilitated through 'smart metering', where 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.

Figure 21 Examples of smart meters

Description
- Smart meters look like standard meters (except with an LCD display and no dials)
- They fit into a standard meter base and no modifications of existing equipment are necessary in order to install a smart meter

Costs
- Estimated incremental costs are £40-£50 per customer, compared to basic credit meters
- This implies a 11% increase above the £800m currently spent by the industry on replacing, installing, maintaining and reading meters annually

Savings
- Electricity smart meters are estimated to save 165 kWh p.a., per meter, or £32 per year at current electricity prices
- Gas smart meters are estimated to save 1,025 kWh p.a.., per meter, or £18.50 at current gas prices

b "Monthly shop"

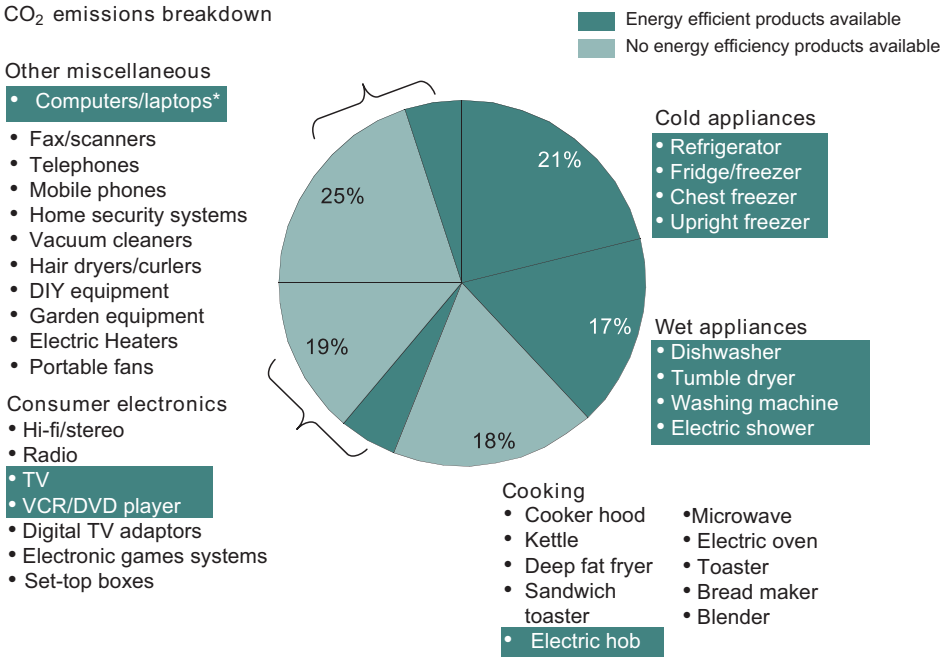
Light bulbs. Londoners can save money and reduce CO_2 emissions from lighting by installing energy efficient light bulbs. Unlike when energy efficient light bulbs were first introduced, new bulbs are available that look similar to traditional bulbs and are available to fit most modern fittings. Energy efficient bulbs use 75-80 per cent less electricity for the same light output, and last on average 12 times longer than traditional bulbs.

Energy efficient lightbulbs typically cost £3-6, but prices are coming down. More importantly, for the most used lights a typical energy efficient bulb will pay for itself within three months, and will then last for 10-15 years.

If every lightbulb in every London home was energy efficient, London could save 575,000 tonnes of CO_2 and £139 million per year.

Appliances. Appliances account for nearly a quarter of domestic CO_2 emissions. Energy efficient models are now available for 50 per cent of products and typically use 30-70 per cent 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.**

Figure 22 Availability of energy efficient appliances

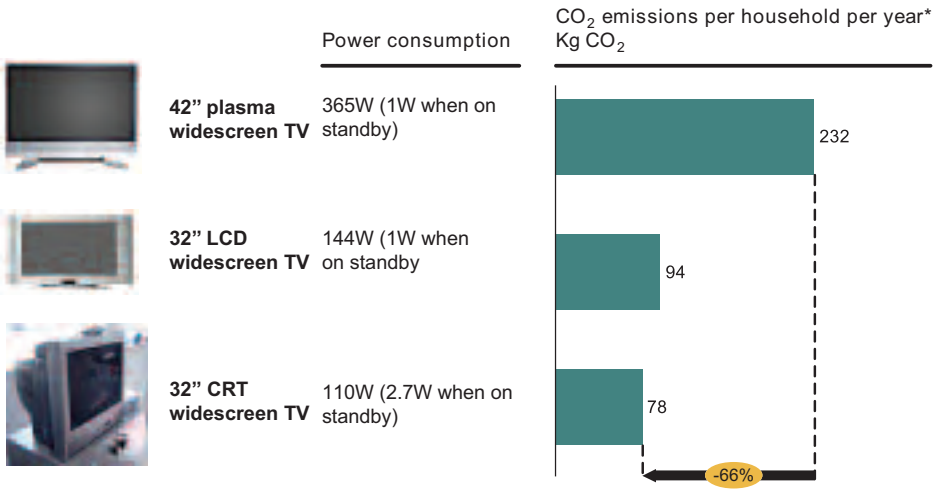


Source DEFRA Energy Strategy; EST

There is significant national and international activity to increase the availability of energy efficient appliances (summarised in Section 4.1.5).

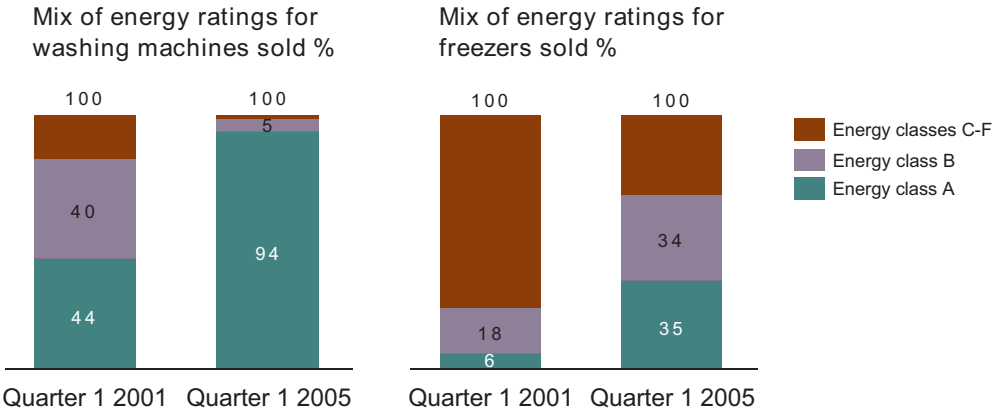
For those appliance types where lower-energy models are offered, energy efficient labelling has been very effective in driving uptake. Recent research from the Energy Saving Trust indicates just under 60 per cent of people look for energy efficient models when purchasing an appliance. In 2005, for example, more than 90 per cent of washing machines sold in the UK were the most energy efficient "A" rating, compared with just over 40 per cent in 2001: a doubling within four years. If people are given the right information and incentives, they will change their behaviour.

Figure 23 Power consumption for different televisions



Source Supplier websites

Figure 24 Purchasing of energy efficient appliances in recent years



Source HM Treasury Energy Efficiency Innovation Review

c "Home improvements and significant refurbishments"

As mentioned above, space and water heating represents 75 per cent of emissions from homes. Putting thermal efficiency measures in homes is one of the most important actions Londoners can take to save on energy bills and combat climate change.

Figure 25 Description of thermal efficiency measures (not exhaustive)

Measure	Description
• Hot water tank insulation	• Hot water tank insulation is a fitted jacket which prevents heat loss. Boilers can also be fitted with insulating jackets, and where appropriate heating and hot water pipes should be lagged.
• Radiator panels	• Radiator panels are reflective panels which fit behind wall-mounted radiators to reflect heat back into the room
• Draught-proofing	• Draught-proofing involves sealing all windows and doors, often with rubber tubing, to prevent heat escaping.
• Loft insulation	• Lofts are insulated with mineral wool quilts, with the insulation laid between joists or at roof level in the rafters. The optimum depth for loft insulation is 250-300mm, although as little as 100mm can be used in conjunction with rigid insulation boards for the same effect.
• Full heating control package	• Full heating control package includes programmable heating and a room thermostat so that the boiler is only on to keep the dwelling warm to a set level, at times when needed. Thermostatic Radiator Valves (TRVs) enable the temperatures in other rooms to be further reduced, if appropriate
• Cavity Wall Insulation	• Cavity Walls are built using two skins of bricks with a cavity 50-60mm wide in between. Most cavity walls can be filled with mineral fibre (most common) or polyurethane insulant injected through holes drilled in the mortar joints. The work doesn't disrupt the interior of the dwelling, and usually takes less than half a day.
• Floor insulation	• Timber floors can be insulated by lifting the floorboards and hanging mineral wool quilts in netting between the joists. Solid floors can be insulated with rigid insulation boards, although this will raise the floor level.
• Replacement condensing boiler	• It is now a legal requirement that when a boiler is replaced it be by a more efficient one, and with greater than 86% SEDBUK. The most common type of boiler which can achieve this level of efficiency is condensing boilers, which extract heat from their hot flue gases through a larger heat exchange.
• Solid Wall Insulation (ext)	• Solid Walls can be insulated externally with an insulation layer fixed to the wall using a combination of mechanical fixings and adhesive, depending on the insulation material used, and a protective render or cladding finish
• Solid Wall Insulation (int)	• Solid Walls can be insulated internally, with 60mm thick rigid insulating board (laminated insulating plasterboard), or a 120mm thick built up system using insulation between a studwork frame, covered with plasterboard, or with Sempatap
• Secondary glazing	• Secondary glazing is cheaper than double glazing but less effective. It is the retrofitting of a second pane of glass either inside or outside an existing window, usually with a separate frame.
• Double glazing	• In addition to double and triple glazing, windows can be manufactured with a low-e coating on the inside face, to reflect radiant heat back into the room. Double glazing is now a minimum requirement in building regulations

Source EST

Cost and CO_2 savings

Fully 33 per cent of heat in a house can be lost through uninsulated walls; a further 26 per cent of heat lost is lost through the roof and 20 per cent through windows. Different measures deliver different levels of energy-savings benefits. Despite the fact that these measures vary widely in upfront cost - from £10 to £5,000 - they nearly all have attractive payback periods (i.e., the period of time it takes for the reduction in energy bills to outweigh the cost of the measure). The less expensive measures (eg, loft insulation) typically pay back within four years or less, and the more substantial measures such as solid wall insulation and condensing boilers pay back within 5-10 years.

The cumulative effect of improving a home's thermal efficiency can be very significant, saving £200-300 (30-50 per cent) off a home's typical annual gas bill. Even simple, low-cost measures like plugging draughts in floors and windows can save £10-20 per year.

Figure 26 Heat loss for a typical uninsulated house

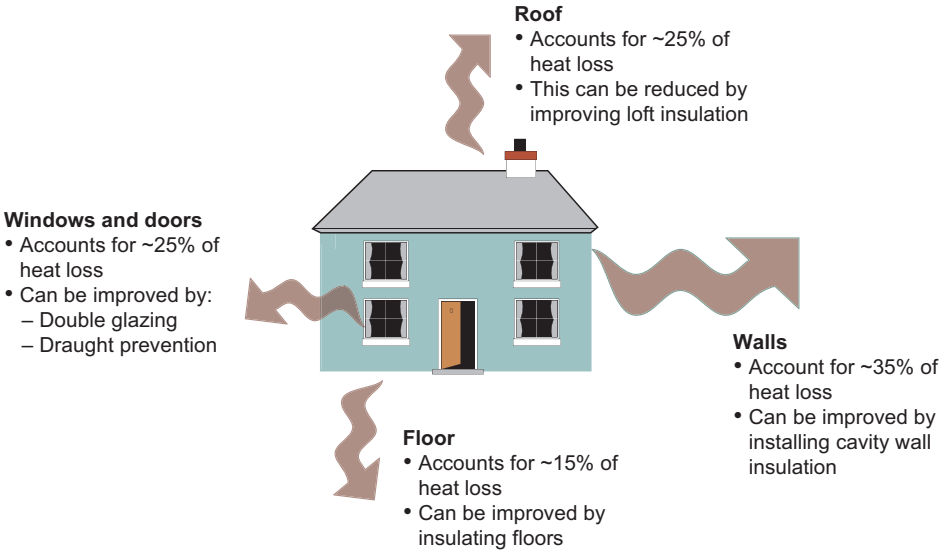
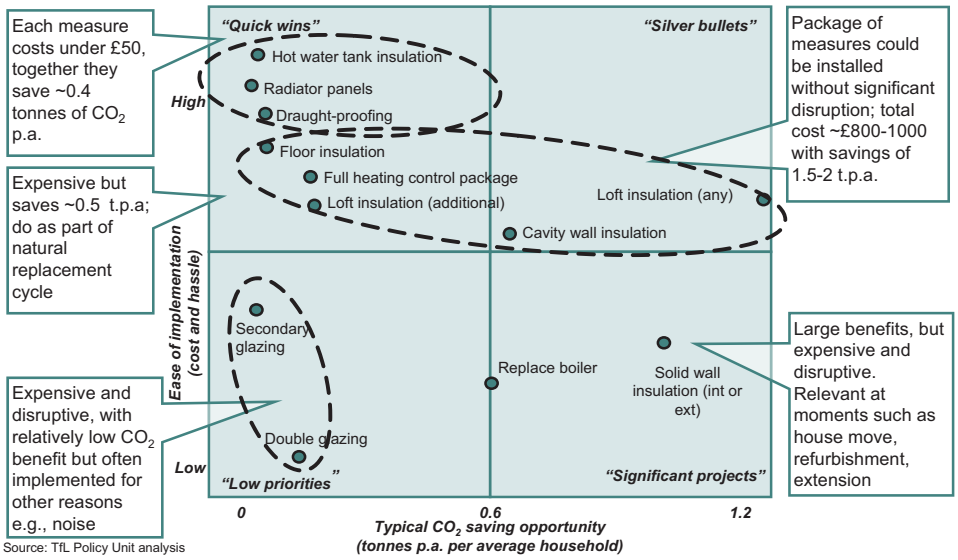


Figure 27 Thermal efficiency measures for London: homeowner perspective

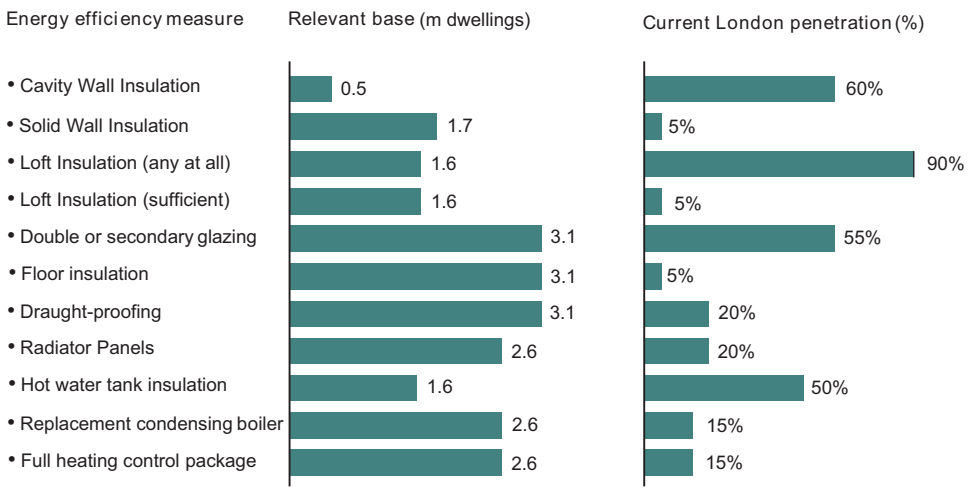


Source: TfL Policy Unit analysis

Installation potential

In London, the potential for each of these measures will depend on a) the proportion of dwellings where different measures will be appropriate and b) the current penetration of those measures. For example, cavity wall insulation is not applicable to older homes, and most homes have some loft insulation (although only ~5 per cent have sufficient loft insulation).

Figure 28 Penetration estimates of thermal efficiency measures in London



Note Estimates
Source EHCS; Element Energy Ltd.; LEP carbon scenarios report

However, although every home and every homeowner will have different requirements, a subset of these measures will be appropriate for every home and every budget. There is no single 'silver bullet' solution that will dramatically increase London's thermal efficiency, but the range of measures available means every home can benefit from greater thermal efficiency, lower heating bills and lower CO_2 emissions.

4.1.5 Actions already underway to tackle emissions from London's homes

Energy efficiency measures

There are a number of initiatives already operating to deliver energy savings in London's domestic sector, most of which focus on energy efficiency measures.

- The **Energy Saving Trust** is the main national provider of domestic energy savings advice through its Energy Efficiency Advice Centres (five in London). This covers thermal efficiency, behavioural change, and micro-renewables in the home, as well as advice on reducing transport energy consumption.
- The **EU Performance of Buildings Directive** is currently being implemented in the UK, with implications for the domestic sector. Under the provisions of the directive all new buildings must meet minimum energy performance standards, and as of June 2007, a valid energy performance certificate (EPC) must be produced for all dwellings at the time of sale, thus raising the visibility of a home's energy performance.
- The **EU Energy End Use and Efficiency Directive** (2006) requires member states to ensure that meters and systems measure customers' actual energy consumption both accurately and frequently. This will potentially pave the way for increased use of smart meters that provide frequent or real-time information on actual energy consumption.
- Linked to this, **trials of smart meters** that provide real-time information on energy use are underway by electricity companies, including EDF, British Gas and Powergen.
- **Here to Help** is a partnership between British Gas and charities in Britain, tackling the root causes of household poverty in Britain's most deprived areas. Launched in 2002, it offers energy efficiency improvements, essential appliances and adaptors, as well as other services from charity partners.
- The government's **Warm Front** programme provides grants for those in fuel poverty to install energy efficiency measures in their homes. This includes the Warm Zones and HeatStreets programmes, which promote the take up of these grants.

- The government's **Decent Homes** programme has provided a valuable foundation for improving some of the worst performing homes. It aims to raise all social housing to the 'decent homes' standard by 2010 and the remainder as soon as possible thereafter. This standard covers a wide range of measures, including thermal comfort, but more emphasis must be placed on improving the energy efficiency of social homes.
- The **Energy Efficiency Commitment** (EEC) scheme requires utility companies to install a certain number of energy efficiency measures, with 50 per cent focused on those in fuel poverty. Due to the nature of its housing stock and therefore the cost of implementation in London, the capital has so far not received its fair share of funding. The London Energy Partnership estimates that in 2002-2005, a maximum of seven per cent of suppliers' investment was spent in London, compared to the city's 12.8 per cent share of the population covered by EEC. If this continues for 2005-2008, the region is expected to miss out on £72.5 million in direct investment.
- The government's LESA scheme (**Landlords Energy Savings Allocation**) introduced in the 2004 Budget provides up to £1,500 tax relief on a range of energy efficiency improvements made to rental properties. Although the 2005/6 budget projected £10 million expenditure on LESA, take-up so far appears to be extremely low, representing a potential tax savings opportunity for London's landlords.

In addition to the range of national initiatives, there are several local initiatives, some targeted specifically at those on income-related benefits, registered disabled, over-60s, etc. These include Bexley's Coldbusters grants for those on income-related benefits; Hammersmith and Fulham's Energy Action Partnership; Islington's Safe and Warm scheme; Camden's WISH scheme; and London Energy Partnership's pilots on sustainable energy technologies and energy efficiency improvements in four Energy Action Areas.

Despite these various commendable initiatives, there is still room for improvement: evidence of more energy efficient behaviour, purchase of energy efficient lightbulbs, and installation of thermal efficiency measures is still low across all segments.

Ensuring the full adoption of grant schemes aimed at the fuel poor and landlords has been a challenging task (although what is required is unlikely to be new schemes, but rather better coordination and publicity around existing schemes). Government schemes (for example, EEC, Warm Front, Decent Homes) don't necessarily prioritise delivering maximum CO_2 and energy savings for Londoners at the lowest possible cost - such a

reorientation could deliver significant additional energy saving benefits from these schemes.

Utility companies have focused their Energy Efficiency Commitment spending (see box above) on areas where installations can be delivered at lowest-cost; the nature of London's housing stock has meant that London has therefore not received its fair share of this investment.

Energy efficient appliances and light bulbs

Significant national and international activity is under way relating to the manufacture and retail of energy efficient appliances, including:

- **Government** is lobbying the European Union for the implementation of the International Energy Agency's 1-watt initiative, which imposes a stand-by power limit on appliances. Government has also started the Retailers Initiative to introduce marketing schemes to raise awareness of the energy efficiency of consumer electronics goods, and has introduced the Market Transformation Programme that advises retailers on how to promote uptake.
- The **European Union** has implemented an energy efficiency labelling scheme (A-F energy classes) and the EU Ecolabel programme (an additional voluntary scheme). It is also setting energy efficiency standards for 14 products as a priority by the end of 2008.
- The **C40 Large Cities Climate Leadership Group**[7], in partnership with the Clinton Climate Initiative, is working on international procurement alliances between cities, in particular for energy efficient lighting.

London will continue to support and lobby for increased and better standards. However, London's main focus is on delivering targeted messages to consumers to accelerate purchases of energy efficient devices that are already available in the shops.

4.1.6 The Mayor's key priorities for action

Overview

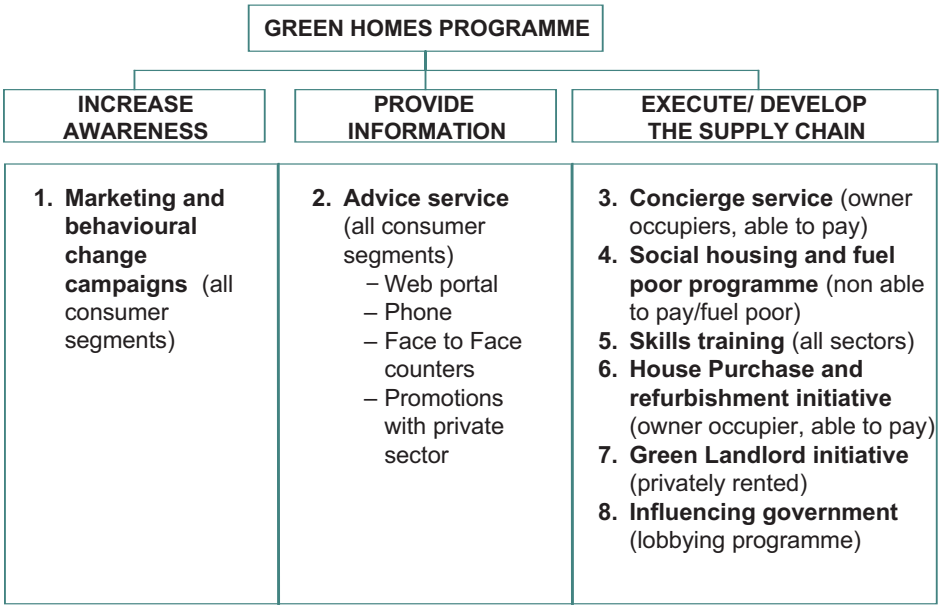
There is considerable evidence for a high level of concern about climate change among Londoners, and a keenness to be involved in reducing emissions. However, there is a plethora of initiatives and a lack of clarity on where to go for advice and support and what is the most effective thing for Londoners to do. The Mayor's strategy is therefore to make it easier and cheaper for Londoners to play their part.

Within the domestic sector, the Mayor intends to pursue a comprehensive **Green Homes Programme**, in collabortion with the Energy Saving Trust. This will coordinate existing initiatives presented earlier in this chapter around a common goal. There will be increased funding, in part to support a major marketing campaign. The programme will encompass eight initiatives aimed at increasing awareness, providing information, helping individuals to achieve energy savings and install renewable energy systems, and developing the sustainable energy supply chain.

The budget for the Green Homes Programme in 2007/08 will be about £7 million. Funding will be provided both by the Mayor and external delivery partners. In the first year, spending will be focused on generating public awareness, developing useful and readily accessible consumer information, and helping to tradespeople to learn relevant skills.

Together, these initiatives will target all consumer segments and are expected to deliver 3.9 million tonnes of CO_2 savings per annum by 2025. **The total energy savings to Londoners of this programme would total nearly £1 billion per year by 2025, or approximately £300 per year per average household.** Additional energy savings (of ~3.8 million tonnes of CO_2 per annum) are achievable from improved energy efficiency of domestic new building, and from improving the energy efficiency of energy supply.

Figure 29 The Green Homes Programme



a Marketing and behavioural change campaigns

A crucial component to delivering real CO_2 savings in London will be simply to explain and promote the many actions that individuals can already take to deliver substantial energy savings and gain from the lower bills that follow.

The marketing initiative will develop and implement a comprehensive, multi-year and multi-channel campaign to educate Londoners on how their homes contribute to CO_2 emissions and how they can reduce their energy bills - no matter whether they own or rent their properties, whether they are able to invest in thermal efficiency improvements or not. Campaigns will focus on energy efficiency, including heating, lighting and appliances; but will also cover transport and air travel. The campaigns will be informed by detailed market research into Londoners' current understanding, attitudes and behaviours on climate change.

Last summer's successful water conservation campaign, developed by the Mayor with Thames Water, reduced London's water consumption by around 10 per cent. In a similar fashion, the Mayor will be looking to work with private sector companies, particularly utility and retail companies, to deliver key campaigns and to promote support services available to Londoners.

b Advice service

The marketing campaigns described above will raise awareness about energy savings opportunities. But most Londoners also need practical information about what specific actions they can take; where they can buy energy efficient appliances; who can help install cavity wall insulation; how get the most reliable micro-renewable products and who is qualified to install them.

The Mayor will establish a single, cohesive, coordinated advice service for London, incorporating both an online and a physical service delivery. This will be done in partnership with the Energy Saving Trust in a new initiative to provide a one-stop-shop advice service covering home energy saving, renewable energy and personal transport. This Sustainable Energy Network will support Londoners who want to take action to reduce their emissions.

At present there are a number of websites and service providers aiming to inform individuals about energy savings. Not all are comprehensive, none are London-specific, (though there are local resources for specific areas of London), and as they are poorly marketed there is scope to increase their reach and impact.

An authoritative and comprehensive 'Green Homes' portal will be developed, accessible by web and phone, to provide comprehensive information on potential improvements from the costs and benefits through to available support and implementation options. The portal will integrate with existing information resources and point people in the right direction rather than seek to replicate what's already in place.

Alternative delivery methods including mobile face-to-face approaches will also be piloted to ensure effective engagement with a broad cross section of Londoners and increase awareness of the support available.

c Concierge service

A green concierge service that takes the hassle factor out of implementing energy savings improvements is currently being piloted with 40 Lewisham homes in partnership between the Mayor, LDA, Energy Saving Trust, and a private provider. This is a fee-based service and includes an energy audit (in varying levels of depth according to the available budget) as well as project management for the implementation of the measures the homeowner chooses.

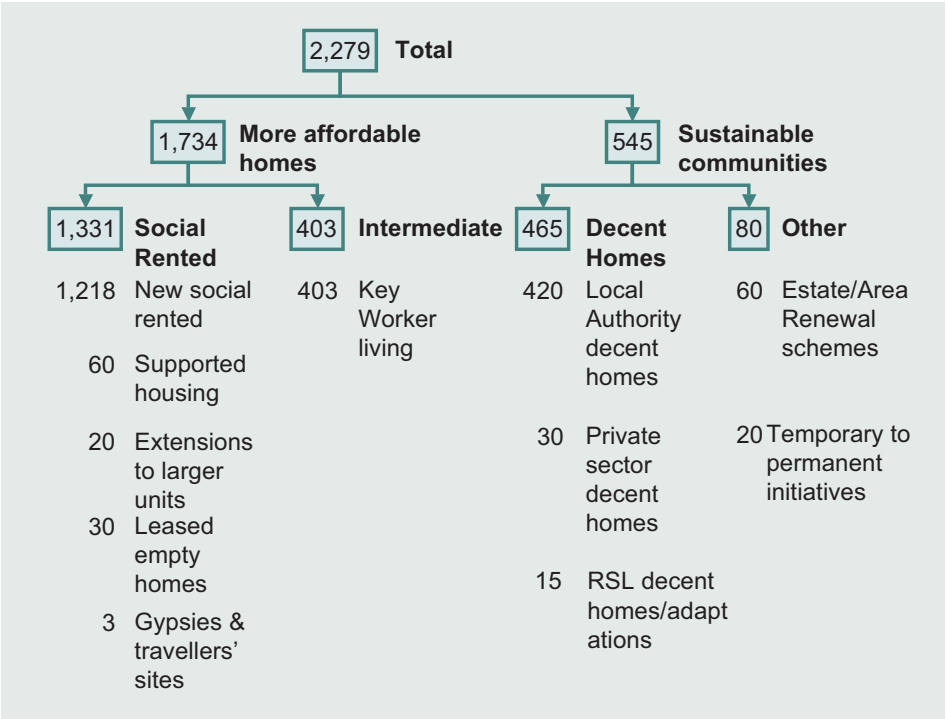
As part of the new Green Homes Service, the current pilot will be rolled out to 5,000 homes over the coming year. In addition to the direct outcome - energy savings in those homes that receive the service - a number of other objectives will be served. The initiative will offer a better understanding of barriers to take-up of these measures, as well as potential gaps in the supply chain as indicated above. For example, it may be that there are not enough energy auditors, or that builders in London are not sufficiently familiar with the installation of certain energy efficiency measures. It will also test the demand for a concierge service and, if the concept is proven, hopefully will encourage other providers to enter this part of the market. Finally, it will help catalyse the development of supply to all consumer sectors by increasing demand for energy efficiency and other domestic green measures.

d Social housing and fuel poor programme

Following the recent review of the Mayor's powers, the Mayor has acquired new powers relating to housing in London. The Mayor has already published his strategic document for consultation on the new housing powers, "Towards the Mayor's Housing Strategy". Tackling climate change will be one of the key strategic objectives of the strategy; the Mayor will be seeking to embed climate change mitigation at the heart of the entire Mayoral Group's work in this area. This will take place through the implementation of the updated Mayor's Housing Strategy and the Strategic Housing Investment Plan, both of which will be finalised during

2007. The new powers will particularly allow the Mayor to address energy efficiency for those in fuel poverty and in social housing.

Figure 30 Overview of London Housing Pot, 2006-2008
£ million



Source London Housing Strategy 2006-08; GLA Housing Team

The Mayor supports the ambition to raise all homes to a decent standard by 2010. But while the existing government standard is a good start for improving the quality of homes, it is not high enough to meet London's carbon reduction targets. The Mayor will therefore argue for an improved standard of housing (i.e., higher than the 'decent' standard) as part of any ongoing Decent Homes programme beyond 2010. Improving the thermal efficiency of houses should be a key aim of a strengthened Decent Homes programme, together with improving the economic, social and environmental quality for the residents affected. A strengthened Decent Homes programme could be used to pilot a neighbourhood approach[8], similar to the Warm Zones trialled by the government.

In the London Housing Pot for 2006-2008, over £100 million was allocated for a number of purposes beyond the core allocations for the Housing Corporation's programme and Councils' Decent Homes programmes - that is for initiatives such as estate regeneration and private sector renewal. The Mayor will ensure that these funding programmes have a much clearer focus on meeting exemplary levels of energy efficiency. This will cut bills for some of London's least well off residents, as well as cutting carbon emissions.

For new construction, the Mayor supports the introduction of more stringent standards, as per the Code for Sustainable Homes (see Chapter 4.3). For existing housing stock, the Ecohomes XB scheme has been developed by the Building Research Establishment and the Housing Corporation for minor refurbishments, and the Ecohomes standard is in use for major refurbishments[9]. At present, both of these are voluntary schemes, and Mayor has no formal power to make them mandatory. Instead, the Mayor will explore ways to further improve the energy efficiency of the existing stock through his Housing Strategy and Strategic Housing Investment Plan.

e Skills training

Transforming London's housing stock requires a skilled and talented workforce, well versed in new technologies and techniques. Yet recent studies, such as the London Energy Partnership Skills for a Low Carbon London, indicate that there may be shortages in this area. Key recommendations from this study include:

- Setting up an Energy Trainers Forum to coordinate energy efficiency and renewable energy training by bringing together professional training providers, professional / trades bodies, Skills for Business and funding bodies
- Rolling out energy training for planners

- Feeding into the work of the London Skills and Employment Board, for example so that it works with the Sector Skills Councils with an energy footprint and so that it encourages colleges and the Learning and Skills Councils to build collaboration and rationalise education and training provision across London.

Delivered by the London Development Agency, in partnership with the relevant professional bodies, this initiative will first confirm which are the priority skill areas to focus on. It will then develop and implement training programmes to enhance workforce capacity and skill levels. To accelerate results, the focus on this initiative will be on embedding energy efficiency training into existing programmes.

Parallel initiatives such as the portal and the concierge service will continue to highlight any supply chain gaps. These will be fed back into the skills training programme to ensure it remains focused on high impact areas.

f House purchase and refurbishment initiative

As identified above, buying a home is a key energy efficiency decision-making moment, since:

- Individuals may be making changes to their homes at this stage anyway.
- Even if they are not planning refurbishments, energy efficiency measures are easier to install and less disruptive if the home is between inhabitants.
- The cost of installing many energy savings measures will be substantially lower if installed at the same time as other changes are being made. For example, putting in floor insulation can cost as little as £100 if work is being done to the floor anyway. Solid wall insulation can cost more than twice as much if installed separately rather than in conjunction with other measures. Crucially, this improves the payback of energy savings measures, and hence their attractiveness to individuals.

One avenue for influencing household decisions to put energy efficiency and other sustainable energy measures in place will be the marketing campaigns described above: that is, making individuals aware of the potential cost and CO_2 savings to be gained if energy efficiency improvements are made at the same time as other works are carried out. Another is to collaborate with organisations that are in contact with individuals buying and selling homes: architects (eg, through the Royal Institute for British Architects, RIBA), surveyors (through the Royal Institute of Chartered Surveyors, RICS), mortgage providers (banks and building societies), estate agents and utility companies. These groups can provide information about energy savings improvements and can

incentivise them (for example, by including energy efficiency measures in mortgages, or offering lower-rate green mortgages or loans for installing sustainable energy systems). The Government's introduction of home energy certificates should create further interest in this from both buyers and sellers, as well as from the property industry generally.

The opportunity for the Mayor to stimulate or support the decision to install energy efficiency or other sustainable energy measures when homes change hands and/or are refurbished will be explored through a feasibility study which will also consider partnering with some of these organisations.

g Green landlord initiative

As discussed above, rented dwellings are difficult to target for energy efficiency due to the landlord-tenant disconnect. One way to address this would be to partner with letting agents to introduce a joint voluntary green scheme that motivates landlords to upgrade their properties, in exchange for being able to badge them as green properties - thus enabling tenants to both reduce their CO_2 emissions and save on energy bills.

A feasibility study will be carried out to assess the potential to work/partner with letting agents in London to develop and roll out such a scheme. This scheme would simultaneously seek to promote the Government's LESA funds, which would financially benefit those landlords in London who did put energy efficiency measures in place.

h Influencing government

Finally, the Mayor will look to influence government in a number of areas. He will respond to the formal Energy Efficiency Commitment 3 consultation, lobbying for the inclusion of renewable technologies as well as energy efficiency, and push for a system that ensures London gets its fair share of funding.

As mentioned earlier, the Mayor is keen to see a strengthened Decent Homes programme continue after 2010; and London would welcome trialling a renewed programme with thermal efficiency as one of its primary aims. The Mayor will await the outcome of trials of smart meters, and potentially lobby government in order to increase their usage.

The Mayor supports EU-level initiatives to increase the usage of energy efficient appliances and lighting, and welcomes the introduction of Home Information Packs from June 2007. This will be an excellent opportunity to strengthen the house purchase and refurbishment initiative element of the Green Homes Programme, discussed above.

Subsidised energy efficiency measures for London

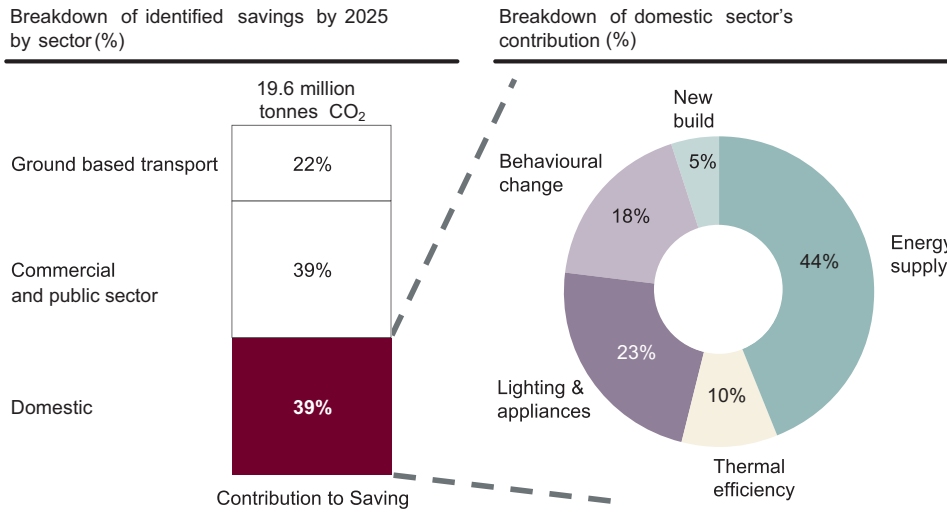
As an initial illustration of what the Green Homes Programme will offer to Londoners, the Mayor is seeking an energy utility partner to offer to install energy efficiency measures in every London home that can benefit from them.

Under the scheme the Mayor will launch a major marketing campaign to promote an offer by the chosen utility to deliver heavily-subsidised thermal efficiency measures, such as loft and cavity wall insulation.

This offer will be free to Londoners in receipt of state benefits. At the time of this document going to print, tenders were being sought and an announcement was expected in March 2007.

If successfully implemented, these Mayoral initiatives will facilitate the delivery of CO_2 savings of 7.7 million tonnes annually by 2025.

Figure 31 Domestic sector's contribution to CO_2 savings by 2025



References

1 For a typical household, average annual electricity bill is £380 and gas bill £630 in 2006. Source: Energywatch, October 2006.

2 Source: BRE/DTI.

3 Continued growth in energy consumption per capita of 0.1 per cent p.a. as per growth over last decade. While this includes improvements from more energy efficient appliances, for example, these are offset by other factors.

4 These reductions are based on a bottom-up assessment of what is achievable, including the profile of London's housing stock, current and estimated future penetration of energy efficiency measures, data from other countries, etc.

5 The Standard Assessment Procedure (SAP) Rating rates the energy efficiency of homes taking into account factors such as window and door specifications, boiler make and model, heating control systems, construction materials, etc. The Mayor's Energy Strategy sets a target of having no occupied dwelling in London with a SAP rating of less than 30 by 2010, and less than 40 by 2016.

6 It is a common misconception that it can be better to leave lights on since it takes extra energy for light bulbs to turn on. It's true that in start-up fluorescent lights use more energy than when they are running continuously - but only slightly more. In fact, if you are leaving the room for anything more than one and a half minutes it actually saves more energy to switch the light off (Source: National Energy Foundation).

7 The C40 brings together many of the world's largest cities to accelerate carbon emissions reductions and was established by the Mayor of London following a summit in London in October 2005.

8 A neighbourhood approach could form part of a low carbon zones strategy for achieving emission reductions: this would be a cross-sectoral approach to CO_2 reductions within a small geographic area, with advantages of stimulating demand for services; achieving economies of scale for providers; scope for combined heat and power plants; and a guarantee that no fuel-poor household falls through the net.

9 Ecohomes XB recognises that existing homes are of different quality, and have different potential for improvement; therefore, the emphasis is on improving homes, rather than on achieving a particular banding. Ecohomes does have particular banding, with homes scored as Excellent, Very Good, Good or Pass.

4.2 Emissions from existing commercial and public sector activity[1]

4.2.1 Overview

Commercial and public sector emissions in London are nearly as large as those from homes. This sector is projected to grow as London's economic growth continues, adding 850,000 new jobs over the next 20 years.

Compared with the domestic sector, a larger proportion of emissions in the commercial sector come from electricity usage. This is primarily due to greater energy consumption for purposes such as lighting and computing. Since current electricity provision has a 125 per cent higher carbon-intensity than for heating, the carbon emissions from the commercial sector are amplified.

Often, energy savings will be easier to achieve in the commercial arena than in the domestic sector, through simple actions like turning off lighting, computers, and other appliances at night and avoiding inefficient heating and cooling of buildings. Furthermore, measures can be taken that provide energy savings for a whole building simultaneously rather than the case-by-case action required for London's 3.1 million homes.

Reducing emissions need not, and should not, impede London's economic growth. Quite the contrary: as in the domestic sector, actions can be taken that both save energy costs and cut CO_2 emissions. In addition to energy bill savings, growing implementation of energy savings measures will bolster demand for renewable technologies, energy-saving building refurbishment measures and the like. London has the opportunity to lead the way in stimulating the new technology markets generally.

One hurdle in delivering these energy savings is that energy bills are typically only five per cent or less of an organisation's cost base - so some organisations will not consider energy savings to be sufficient to warrant considering. Further, there is commonly a tenant/landlord disconnect as most companies do not own their premises. Stricter building regulations will therefore be an important element for catalysing change. However, it should be noted that the corporate social responsibility agenda and increasing energy prices appear to be generating greater attention to, and action on, energy issues.

The rest of this chapter covers:

- Current and projected emissions from London's commercial sector, including CO_2 reduction targets and an overview of key actions required to deliver the target

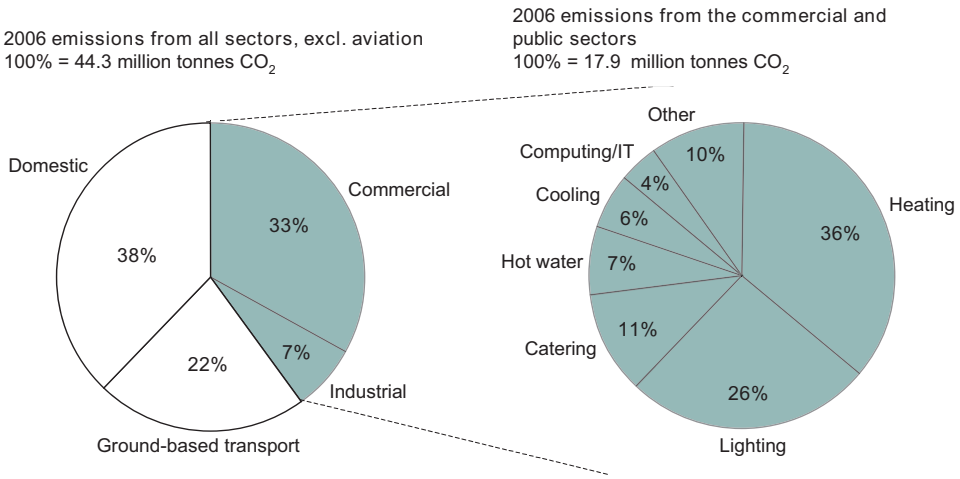
- Specific features of London's commercial sector
- Summary of potential actions to make organisations more energy efficient
- Actions already underway to tackle emissions from London's organisations
- The Mayor's key priorities for action, with indicative CO_2 impact and cost for each.

As with the previous chapter, new build and supply-related savings are addressed separately in Chapters 4.3 and 4.4.

4.2.2 Overview of London's commercial and public sector CO_2 emissions

Current emissions. London's commercial and public sector[1] currently emits 17.9 million tonnes of CO_2 per annum, representing 40 per cent of London's total CO_2 emissions. This includes the public sector (including government buildings, education and health) which is responsible for an estimated 25 per cent of these emissions. The main sources of emissions are heating (both space and water) and lighting[2]:

Figure 32 2006 CO_2 emissions from the commercial and public sectors



Source LECI; DEFRA

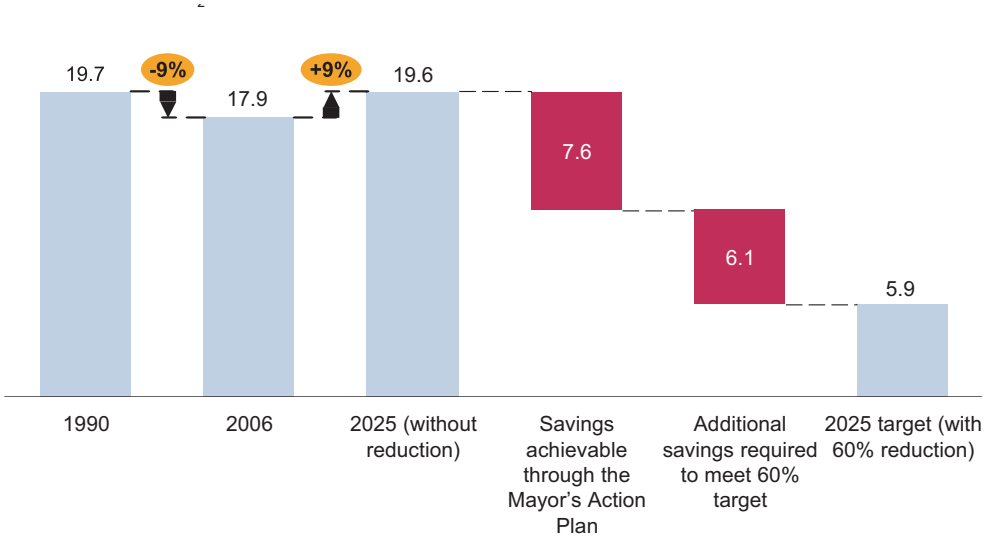
Future emissions

London's business as usual emissions from the commercial and public sector[1] are projected to increase to 19.6 million tonnes of CO_2 per annum by 2025, an increase of 9.5 per cent from today's levels, driven by economic growth and partially offset by a reduction in activity in the industrial sector[3, 4].

Sectoral target

Taking the target of a 60 per cent reduction by 2025 from the 1990 baseline, the commercial and industrial sector would need to emit 13.7 million tonnes less CO_2 p.a. by 2025 (including savings from a reduced carbon energy supply and more energy efficient new building). Achieving this reduction will be extremely challenging, realistically requiring the establishment of a carbon pricing system and further EU and UK legislation. However, in the current environment, a saving of 7.6 million tonnes is achievable by 2025 (including savings from supply and new builds).

Figure 33 Commercial and public sector - comparison of 2025 CO_2 emissions with and without 60 per cent reduction
Million tonnes of CO_2



Overview of how savings can be achieved

There is significant opportunity to reduce CO_2 emissions in this sector, estimated at about 7.6 million tonnes per annum compared to the 2025 business as usual scenario. These reductions can be achieved through the following measures:

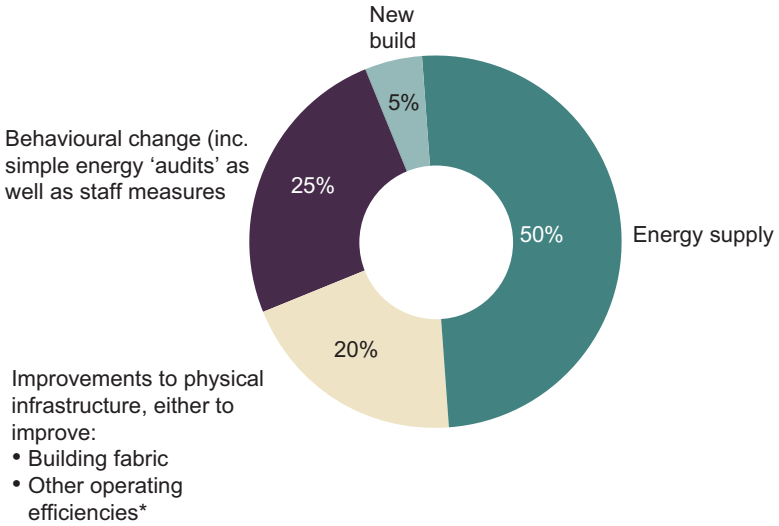
- Driving behavioural change across organisations to ensure employees enable power save modes on their computers, and generally switch off all appliances at the end of each day, as well as carrying out basic energy 'audits' on a regular basis. This is estimated to reduce commercial sector emissions by 10 per cent, and account for approximately 25 per cent of reduction possible by 2025.
- Improving the energy efficiency of the existing building stock through physical upgrades. These could be to the building fabric (for example, improving insulation), or to enable operating efficiencies such as installing motion sensor lighting, or building management systems.

This is estimated to reduce commercial sector emissions by 8-10 per cent, and account for approximately 20-25 per cent of reduction possible by 2025.

- More broadly, reductions also come from:
  - decreasing the carbon intensity of our energy supply through increased reliance on renewables in the national grid, and through increased reliance on decentralised energy. This is estimated to reduce commercial sector emissions by 20 per cent, and account for approximately 50 per cent of the total reduction possible by 2025.
  - capturing CO_2 reductions in new build through the application of increased energy efficiency standards. This is estimated to reduce commercial sector emissions by 2-3 per cent, or account for approximately 5 per cent of the total reduction possible by 2025.

Note that these numbers are averages for the whole sector. Obviously, the savings achievable will be different for each individual company - some companies will have already taken steps to reduce their carbon emissions, while others will have a longer way to go. Similarly, certain types of businesses produce more carbon emissions than others (for example, businesses that rely heavily of transport), which may offer more opportunities for savings.

Figure 34 Sources of savings in the commercial and public sectors



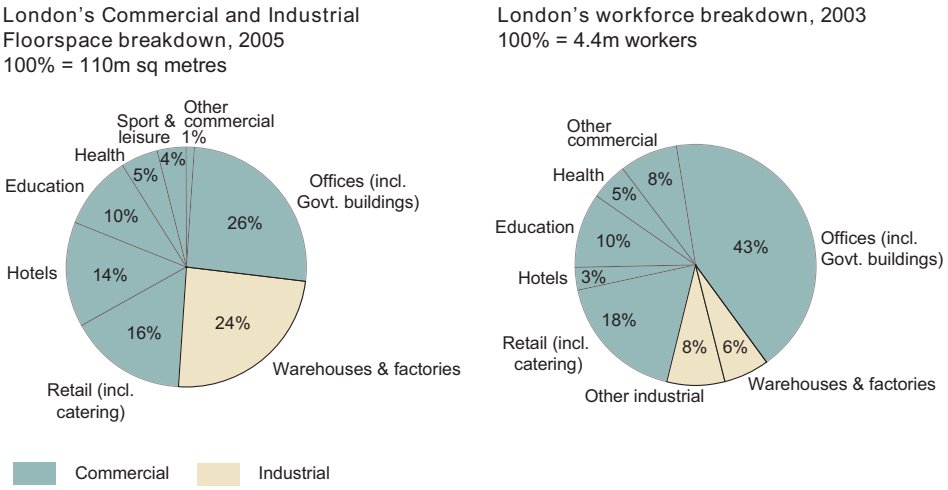
Note * eg, installation of motion sensor lighting

4.2.3 Specific features of London's commercial sector

Breakdown by type of activity

London has approximately 110 million square metres of floor space dedicated to commercial and industrial activity, of which three-quarters is commercial. While certain targets would be better implemented and monitored by considering the floor space of different sectors (for example, targets concerning buildings' physical infrastructure), other targets would be better implemented by considering number of employees in each sector (for example, behavioural targets).

Figure 35 Breakdown of London's commercial and industrial floor space and workforce by sector



Notes Retail includes employees in the wholesale sector; other industrial includes construction, primary and utility employees, and 25 per cent of transport and communication employees

Source ODPM Commercial and Industrial Floorspace and Rateable Value Statistics, 2005; BRE; GLA

Common barriers to energy efficiency

As mentioned above, there are typically two key barriers to the implementation of energy savings measures in commercial organisations:

- **Ownership versus tenancy**. Most organisations occupying commercial buildings do not own the buildings: approximately 90 per cent of office space is leased and around 40 per cent of office buildings are multi-tenanted. This tenant-landlord disconnect is a key barrier to upgrading the energy efficiency of buildings: the tenant benefits from the upgrade, in the form of lower energy bills, but the landlord would typically bear any building upgrade costs. The presence of managing agents in some instances complicates matters further.

Finally, responsibility for energy consumption is often split between various parts of the organisation - facilities managers, procurement departments, fleet managers - which can make effective decision-making difficult. The fact that many buildings are multi-tenanted means that agreement must be reached between many different parties before work that affects the whole building takes place.

- **Energy costs**. The challenge is even greater since energy costs represent a relatively small proportion of the total cost base of a commercial organisation (about 1-6 per cent). This creates little direct economic incentive for change for many organisations. This problem is often exacerbated because the energy costs are further obscured: bills are either usually based on estimates with actual readings taken very infrequently, or bundled with other charges as a general service charge for the building. This makes it difficult to understand both current levels of energy consumption and the subsequent savings realised from efficiency measures and actions taken.

Overcoming barriers

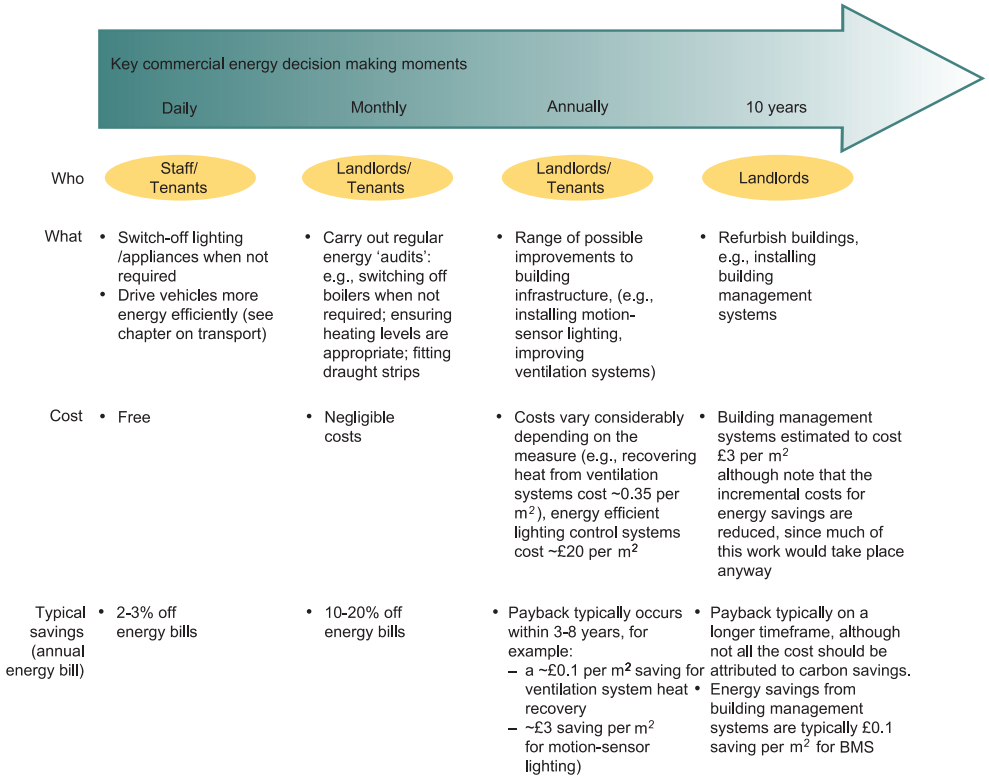
There are a number of positive trends that are creating greater potential for energy savings.

- **Energy and climate change**. Both climate change and energy costs are a rising concern for many organisations, and this is starting to drive changes. Energy efficiency is one of the cheapest ways for a commercial organisation to deliver corporate social responsibility.
- **Ownership structure**. A relatively small number of landlords own a relatively large proportion of the commercial buildings in London.

4.2.4 Summary of potential actions to make the commercial sector more energy efficient

To realise energy savings benefits, action will need to be taken by both landlords and tenants at key moments of opportunity. This ranges from daily switching off of lighting and computers to building refurbishment every five to ten years. Different actions all have different payback periods (i.e., the period of time taken to recoup the capital outlay through reduced energy bills), ranging from zero (i.e. those actions with no capital outlay) to over 20 years.

Figure 36 Overview of action required



Opportunities for these measures to be taken are surprisingly numerous.

a Daily and monthly: Behavioural change

There are a number of simple, typically zero-cost actions that staff could take to achieve considerable carbon savings. By turning off computers and other appliances such as photocopiers at night and over weekends (for example, when security guards check through a building at night); and better use of energy-saving features when computers are out of use for substantial periods of time, staff could immediately reduce carbon emissions from their offices.

Energy 'audits' should be carried out on a frequent basis. Such audits reveal simple, low cost actions that can be taken to improve a building's energy efficiency, for example, ensuring that thermostats are set to appropriate levels, checking seals on refrigeration units, ensuring that air conditioning is used efficiently, etc.

These simple actions could deliver a reduction of 1.9 million tonnes of CO_2 and £325 million off energy bills if 60 per cent of firms in London adopted them.

Case study: BSkyB
In 2006, Sky introduced a carbon strategy, aimed at reducing energy use, and improving energy efficiency across the business. They are now using 100 per cent renewable energy at all sites in England, have fitted more efficient air conditioning systems, implemented solar lighting with motion-sensor controls, as well as encouraged staff to switch off PCs, TVs and lights when not in use.

With a view to 'greening' the supply chain, all relevant tenders and contracts now include a review of the supplier's sourcing, manufacturing plant environmental performance and people policies. Suppliers are asked to source and supply greener products and Sky is currently reviewing its van fleet to investigate alternative fuels and technologies for reducing carbon emissions.

In order to involve staff, a carbon credit card has been introduced, where staff can earn credits (and be entered into a prize draw) for various activities, including suggesting new ways for Sky to reduce its carbon emissions. Additionally, the company offers incentives for purchasing hybrid cars, and has developed transport plans for its various sites.

b Annually: Procurement of appliances, vehicles; redefining building operations

The second major opportunity to achieve carbon savings in the commercial sector is through operating efficiencies and practices. Sometimes these require some infrastructure improvements. As in the domestic sector, procurement of energy-efficient lighting and appliances would not only generate carbon savings, but also have a relatively short financial payback period.

Unlike homes, where decisions to turn lights and appliances on and off have to be made by individuals every day, in commercial premises many of these decisions can be programmed for the whole building by facilities managers. For example, through installing motion-sensor lighting which are only activated when a room is occupied.

Firms that use transport for their operations can procure lower-carbon vehicles and use the lowest-carbon transport that is available for the task, for example, using bike couriers rather than vans to deliver packages. There is further information on the types of vehicles and engine technologies that could be used in chapter 4.5.

Procurement of better appliances, and more energy efficient lighting systems could deliver a reduction of 0.9 million tonnes of CO_2, saving £160 million off electricity bills, if 60 per cent of firms in London adopted them.

Case study: The London School of Economics

The London School of Economics and Political Science (LSE) occupies 100,000m^2 in the heart of London, in the London Boroughs of Westminster and Camden. The estate comprises 22 campus buildings, providing offices and teaching space to around 2,000 staff and a community of some 8,500 students. LSE also has halls of residence in the London Boroughs of Camden, Islington, Southwark, Tower Hamlets and Westminster which provide accommodation for around 3,400 students. Energy expenditure for 2005-2006 was over £2 million resulting in over 12,000 tonnes of CO_2 emitted. As part of the Carbon Trust's Higher Education Carbon Management Programme, LSE has drawn up a long term carbon management strategy with the key aims of:

- Raising awareness amongst all key stakeholders for behavioural change
- Encouraging good energy efficiency practice
- Introducing an environmental management system for effective monitoring
- Demonstrating leadership in the global arena.

LSE is committed to becoming an international leader in carbon management and sustainable development through education, innovation and inspiration. Its vision is to incorporate environmentally friendly and sustainable practices within all modes of operation, and to work collaboratively with internal and external parties to tackle climate change.

c Every 3-10 years: Energy savings measures as part of refurbishment, new tenancy

More significant energy savings opportunities come from refurbishment of buildings, and improving their thermal efficiency. Commercial buildings are typically refurbished every ten years, and energy efficiency improvements can be more easily made during refurbishment. Most commercial premises in London are leased, rather than owner-occupied. Leases are typically quite short (averaging three years for retail space and five to seven years for office space) - premises can be more-easily improved when leases change hands.

There are several measures to reduce carbon emissions that can be considered at the time of refurbishment. The following is a non-exhaustive list of possible ideas:

- Windows should be double, or secondary glazed (or potentially tripled glazed, although this is still relatively specialised). High performance glass can be used, that reflects heat, keeping external heat out, and internal heat in the building. Note that there are some lower-cost solar control films that perform the same function.
- New doors should have good thermal performance, and the installation of cost-effective draught lobbies (where a double set of doors reduces the heat lost from main entry doors) should be considered.
- Any external cavity walls should be filled with insulation. More specialised approaches can be taken, for example, external insulation cladding, or exposing the fabric of heavyweight-building-fabric premises, so that the fabric acts as a sponge, allowing buildings to heat up more slowly and hold their temperature for longer.
- Insulating ceilings and floors reduces energy costs, and also prevents the upper floors from overheating.

Such thermal efficiency measures could deliver a reduction of 0.7 million tonnes of CO_2, and £120 million off heating bills, if 40 per cent of firms in London adopted them.

Case study: Guy's and St Thomas' NHS Trust

Guy's and St Thomas' NHS Foundation Trust has two large, central London sites, with a combined energy consumption of over £12 million per annum. They have brought together different strands of energy management into a single, coherent programme, supported by the Carbon Trust, with the aim of reducing energy consumption, without adversely affecting the environment for patients or staff. The targets are:

- to make significant energy, cost and CO_2 savings by raising staff awareness
- to achieve consumption savings of 10 per cent per year over three years
- to save 3,000 tonnes of CO_2 over three years.

Spend to save investments will take place during the programme, in order to capture the energy and financial savings targeted. These include improvements to lighting design and control; thermal insulation measures and better use of temperature control systems. Additionally, the trust is considering the feasibility for installing Combined Heating and Power energy supply at both sites that would further increase the CO_2 savings.

An energy awareness campaign will feature road shows and team briefings, as well as publicity materials. This emphasises the importance of energy efficient behaviours both at home and at work, and highlights that conserving energy can be as easy as wasting energy.

Indirect influence

One of the most significant actions any organisation can take is to persuade their employees to save energy in other areas, including from their homes and transport decisions. If London's 360,000 employers were able to influence all their nearly four million employees to save energy through their personal decision-making, this could add up to the same carbon savings as the direct savings from the commercial sector.

Large employers are particularly significant in this regard: the largest 10 per cent of London's employers employ 70 per cent of London's workforce, and the largest 300 employers alone employ 10 per cent of London's workforce. Public sector organisations represent 40 per cent of the largest 300 employers.

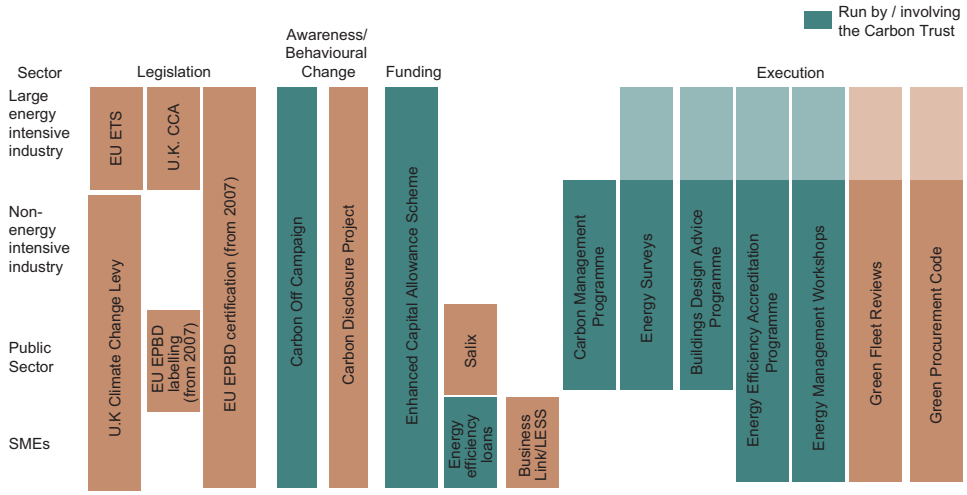
Offering information to employees on how to save energy is very low cost and helps those employees who want to save money or reduce their emissions. Some employers take more significant measures, such as offering bicycle loans or even providing free folding bikes; subsidising public transport fares; providing Oyster cards for employees; making washing and changing facilities available to encourage cycling; and other financial incentives to promote energy efficient behaviours.

Big businesses and other organisations can also have indirect effect on the environment by influencing their supply chains. A number of organisations from different sectors are now working with supply chains in order to achieve environmental benefits.

4.2.5 Actions already underway to tackle emissions from London's commercial and municipal sector

There are already numerous initiatives underway to encourage energy savings in the commercial sector.

Figure 37 Current landscape of major initiatives



- The **Carbon Trust** is currently the most significant organisation acting in this area, both in terms of its profile and the number of initiatives it has running. The Carbon Management programme is particularly key as it provides a facilitated approach for organisations with significant energy bills to identify CO_2 saving opportunities and options. The methodology in this programme has been tailored to target specific sub sectors including the private sector, local authorities, higher education and the NHS.
- The **Energy Saving Trust**'s green fleet reviews provide organisations running more than 50 vehicles with consulting support to consider ways to both improve bottom line and to reduce impact on the environment. This includes providing vehicle choice lists, alternative fuel ideas and suggestions on delivering fuel savings (for example, driver education and reducing mileage through better journey planning).
- The **Mayoral Group**'s key initiatives in this area include the Mayor's Green Procurement Code (MGPC). The MGPC was originally a voluntary scheme designed to stimulate demand for and purchase of recycled content products but will shortly be relaunched to cover water and energy issues and to support and reward demonstrable behaviour change. The London Environmental Support Services (LESS) was launched in 2006 to provide a first stop shop for all businesses to access appropriate advice and support on reducing their environmental impacts and improve resource efficiency. LESS links in with the wider Business Link for London service.

In addition there is significant legislation acting in this sector at a national and international level, including:

- The **EU Emissions Trading Scheme** (EU-ETS) is a cap and trade scheme covering direct emissions from about 50 per cent of the large, energy-intensive industrial sector.
- The **UK Climate Change Agreements** (CCA) are emissions targets set at a sectoral level for large, energy-intensive industry. Trade bodies in each sector translate and distribute these targets to individual companies.
- The **UK Climate Change Levy** (CCL) is an end-user tax on all non-domestic energy use. Those companies with CCAs or in the EU-ETS are rebated 80 per cent of the CCL.
- The **EU Energy Performance of Buildings Directive** requires buildings to obtain two energy ratings: an operational rating (tenant facing) and an asset rating (landlord facing). It also requires public buildings to display their ratings publicly.

Government has recognised that there is a need to control carbon emissions non-energy intensive commercial users. The Department of the Environment (DEFRA) are currently consulting on the possible introduction of the Energy Performance Commitment (EPC) which is designed to bring carbon pricing into effect for larger commercial operations. It has been estimated that across the UK there is the potential for this measure to save 1.2 million tonnes CO_2 by 2025.

The EU Emissions Trading Scheme and the UK Climate Change Agreements are only marginally relevant for London given that large, energy-intensive industries are typically located elsewhere. If the EU-ETS were expanded to cover the entire commercial sector then the CCA and the Climate Change Levy would no longer be required. This is one of the ideas being discussed in the context of revisions to the EU-ETS (discussed later in this chapter under the Mayor's lobbying programme).

Overall, despite these initiatives and legislation:

- **Low take-up**. There is still relatively low take-up of these measures in the commercial sector. While there are a relatively large number of organisations and initiatives seeking to address commercial emissions, it is not anywhere close to a corporate norm to review and address energy efficiency. In fact, the range of initiatives seems to create some confusion and hence inaction. Among those companies who do review their energy efficiency, often only partial measures are taken for purposes of tokenism.

- **Weak economic incentives**. The weak economic incentives for energy savings mean there is no strong financial motivation for change. This is changing somewhat with the increasing importance of corporate social responsibility and rising energy prices, but not significantly yet. Tax relief and interest-free loans are available from government but again these do not appear to have radically increased take-up.
- **Incentives and trading mechanisms**. Most of the pricing incentives and trading mechanisms relate to energy-intensive heavy industry with little incentive placed on the rest of the commercial sector. Existing trading schemes have had some difficulties getting off the ground due to the nascent nature of the market and questions over the allocation of credits between and within countries.

4.2.6 The Mayor's key priorities for action

Given the significant activity already underway in the commercial sector, the mayor will seek to build on existing, successful initiatives through partnerships and alliances. In particular the Mayor will focus on the following key areas through a **Green Organisations Programme**:

a Encouraging and rewarding landlords to upgrade their building stock through the **Better Buildings Partnership**
b Encouraging and rewarding private and public sector organisations (tenants) to "green" their operations through a marketing and signposting scheme - the **Green Organisations Badging Scheme**
c A **lobbying programme** which will support both the Better Buildings Partnership and the Green Organisations Badging Scheme.

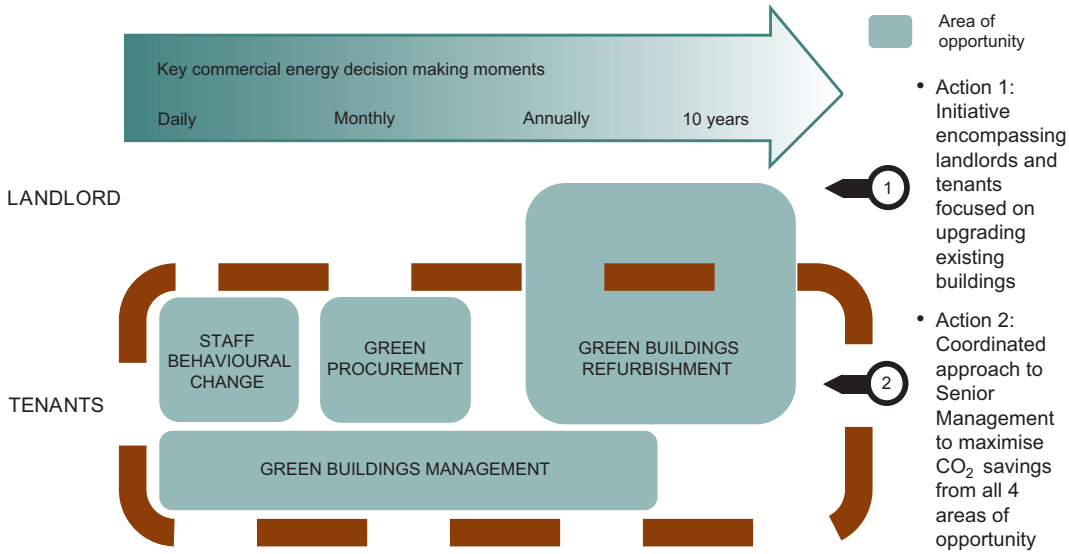
The ambition for the Green Organisations Programme is to have an overall reduction of energy use from the commercial sector in London of approximately 20 per cent from 1990 levels by 2025, with a further 20 per cent reduction from more carbon-efficient energy supply and new buildings. In order to kick-start the achievement of this goal, the programme aims to have facilitated the following:

- introduction of operational efficiencies in 40 per cent of companies in London by 2015
- use of energy efficient lighting systems and appliances in 40 per cent of companies by 2015
- building fabric improvements to thermal efficiency in 25 per cent of building premises by 2015.

The budget for the Green Organisations Programme in 2007/08 will be about £1 million. The Mayor and/or London Development Agency will fund the programme with external delivery partners. Approximately half of this

budget will be for the Green Organisations Badging Scheme, where the team with develop and test the concept, by piloting with key organisations.

Figure 38 Areas of opportunity for London should focus on to maximise emission reductions



a Better Buildings Partnership

This programme will address London's existing buildings, and be focused primarily on landlords, and the actions they can take to improve the energy efficiency of their buildings. It will take forward exploratory discussions between the London Climate Change Agency and a range of landlords, tenants and building experts about how best to upgrade London's existing building stock. This programme will support landlords to establish and upgrade the ratings of their buildings in the context of the European Union's asset rating certification for buildings which is due to be implemented in 2007. The Better Buildings Partnership (BPP) will offer:

- High-level forum for leaders in the commercial buildings sector in London, aimed at learning and sharing success, and engaging with and motivating others. Currently, the London Climate Change Agency is working with the Corporation of London and British Land to study the issues surrounding landlord/tenant relationships and lease agreements that impact on a lack of action in terms of tackling climate change.
- Recognition and reward, where buildings are publicly scored on the basis of EU Energy Performance of Buildings Directive (EPBD) asset and operational ratings, and awarded Mayoral-endorsed charter marks. This will be coupled to a Mayor's list of accredited consultants

and contractors who can help landlords to improve the rating of their premises.
- The Better Buildings Partnership (through the London Climate Change Agency, with the Corporation of London) may conduct a 'trial run' to survey and establish energy performance levels of sample buildings in London's commercial sector in advance of the implementation of the EU-Energy Performance of Buildings Directive[4].
- Support and follow-through with middle management, facility management and energy management levels to achieve emissions reductions. The London Climate Change Agency is working with the Corporation of London to update, develop and disseminate technical information, best practice and case studies.

The partnership is currently being developed: so far, conversations have been held with a range of organisations including major landlords, tenants, managing agents and building experts. Going forward a Mayoral-group-led team will develop a programme that guides landlords through the identification and implementation of appropriate measures for their buildings and publicly recognises their achievements in reducing CO_2 emissions. A revolving fund may be set up to catalyse the refurbishment of commercial premises.

The partnership will provide specific advice for different commercial sectors, and for different building-types, on what are the best measures to take. It will work with commercial letting agents to develop a voluntary green scheme that will further encourage landlords to take action.

One of the barriers that the Better Buildings Partnership will need to address is the different perspective of landlords and tenants referred to earlier in this chapter. The partnership will need to be structured in such a way as to facilitate overcoming this barrier.

The initial focus will be on commercial buildings but subsequent rollout is envisaged for the public sector and small to medium-sized enterprises, potentially alongside low cost green finance options. In addition, the Mayor will explore the possibility of a voluntary green landlords scheme that could catalyse landlords to take action more quickly and thoroughly.

Case study: Toronto Better Building Partnership
The Better Building Partnership (BPP) in the City of Toronto was established in 1996 as a public private partnership to take a lead role in the City of Toronto's overall CO_2 reduction commitment. To date, the programme has overseen energy efficiency retrofits and building renewals in both the private and public non-profit sectors, with a total project value of approximately $100 million. 155 participating BBP buildings located in the City of Toronto have created approximately 3,000 jobs, reduced building operating costs by over $6 million, and cut 72,000 tonnes of CO_2 emissions per year. These achievements are in excess of the original targets set for the scheme.
The Better Building Partnership projects are implemented by Energy Management Firms. These provide a comprehensive package of professional services, as well as customised and innovative financing packages. Financial institutions were involved in the partnership from an early stage and have enable project financing to be provided at competitive interest rates.

b Green Organisations Badging Scheme

This programme will look to improve operating practices within London's buildings, and therefore be more applicable to tenants rather than landlords. Building upon the Mayor's Green Procurement Code and London Environmental Support Services, it will begin with an assessment of the potential impact of a Mayoral endorsed scheme across London to encourage and reward organisations to reduce their carbon footprints. It will examine the potential in the large commercial sector (primarily large office and retail buildings), as well as the public sector and the potential to support small to medium sized enterprises (SMEs).

The programme will not introduce new approaches and initiatives for organisations to follow but, through partnership, would seek to promote and signpost currently successful initiatives and to publicly recognise outstanding achievement. It will seek to work with business leaders to influence other organisations within their sectors to put in place measures to reduce their carbon emissions and to engage with their employees to promote the Green Homes Programme.

The scheme will recognise different levels of achievement and should be tailored to different sectors, recognising that energy reductions are more easily achieved in certain sectors than others. The scheme will be able to build on the European Union operational rating certificates, and to update targets on an annual basis, in order to drive continuous action.

The Mayor will work with major partners (for example, Carbon Trust, CBI, London First) to co-design and endorse the scheme, and seek visible sponsorship from sector-specific bodies, such as the British Retail Consortium or the British Banker's Association. Initially, proactive companies with a high credibility and profile will be targeted, and within companies, efforts will be made to work with senior management figures to secure buy-in across the organisation

Economic opportunities

The Mayor's aim is to make London the world's leading centre for research and financial services related to climate change.

- **London, with the rest of the UK, should establish itself as the world leader in research into climate change and how to tackle it**
  With the Tyndall and Hadley Centres and other UK universities, London's higher education institutes should continue to establish and market themselves as global leaders in research into climate change: including forecasting climate change, estimating its effects and its future costs, and developing the new mitigating and adaptive technologies required to meet the climate change challenge.

- **London should continue to establish itself as the world leader in financial development on climate change**
  London's businesses will need to continue to collaborate to develop and promote the city as the pre-eminent centre for:

  - carbon emissions trading
  - financing new green technologies
  - establishing and investing in green funds
  - bridging the gap between research and the financial backing required to develop new climate change products
  - pricing climate change risks.

  To complement the initiatives of the Green Organisations Programme, the London Development Agency's Science and Industry Council, Catalyst (an advisory body comprised of senior representatives from higher education and from business) has been considering the implications of climate change and the emerging recommendations are currently being fed into the LDA's investment plans for 07/08.

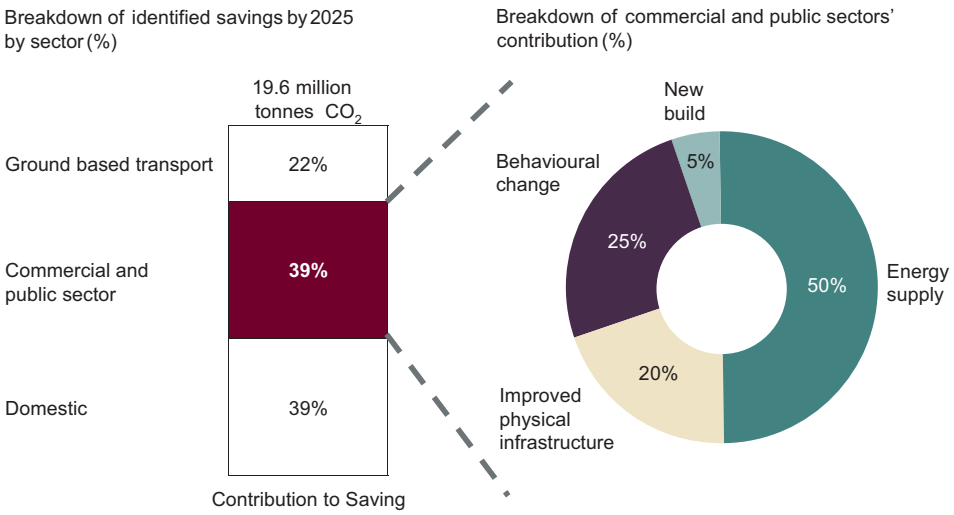
c Lobbying programme

Finally, the Mayor will look to influence government through our lobbying programme in a number of areas. The EU Energy Performance of Buildings Directive came into force in January 2006, but the UK has exercised its option to delay its introduction for the maximum allowable three years. The Mayor will call for this delay to be overturned, and will push for **all** buildings having to display their building asset rating, rather than only 'public' buildings. Additionally, he will lobby for requiring the operational rating (as well as the asset rating) to be displayed

The Mayor supports the European Union Emissions Trading Scheme, and is keen to see its expansion to new sectors (potentially for all commercial and public sector organisations). This would not only have direct environmental benefits for London, but also economic benefits if London establishes itself as a centre for carbon trading. Finally, the Mayor would welcome the introduction of Energy Efficiency Commitments for small-to-medium-sized enterprises (see Chapter 4.1 for a discussion of EECs for the domestic sector) - this could either be as part of the domestic programme, or as a separate scheme.

Taken together, and successfully implemented, these mayoral initiatives will facilitate the delivery of CO_2 savings of 7.6 million tonnes annually by 2025[5].

Figure 39 Commercial and public sectors' contribution to CO_2 savings by 2025



References

1 For purposes of this document, "commercial and public sector emissions" will be used to refer to commercial, industrial, and public sector activity (including local and national government buildings, schools, universities and hospitals), unless otherwise specified. Given the relatively small contribution of the industrial sector to London's emissions, and its natural projected reduction, the main emphasis is on the best actions to take in the commercial and public sectors. However, where appropriate, similar actions will be rolled out to the industrial sector.

2 For large commercial buildings, air conditioning is large CO_2 emitter. In addition, electric air conditioning and refrigeration plays a much bigger role in greenhouse gas emissions or CO_2 equivalent emissions through their use of very powerful greenhouse gas refrigerants.

3 Growth rate based on: 1.1 per cent growth per annum in office space, associated with 510,000 new jobs in the finance and business services sector; 0.9 per cent growth per annum in retail and leisure space, associated with 333,000 new jobs; 0.4 per cent growth per annum in other commercial sub sectors, associated with a further 234,000 jobs; overall decline in the industrial sector of 19 per cent.

4 Western European city buildings have much higher energy efficiency than UK buildings due to improved energy efficiency standards and greater penetration of decentralised energy. It is important to understand how much out of step London's buildings are and what commercial impact the directive may have on the market in time to stimulate action before the directive is implemented.

5 This includes the savings from more carbon-efficient energy supply and new buildings.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4.3 Emissions from new build and development

4.3.1 Overview

UK buildings have historically been designed and constructed based on an assumption that fossil fuel supplies were plentiful and cheap, so energy efficiency was largely irrelevant. London's relatively benign climate, with mild winters and unchallenging hot summers, also minimised the need for more efficient heating and cooling. Opportunities to harness renewable sources of energy were largely ignored.

This model won't work in a future affected by climate change. Ensuring that new buildings are designed and constructed to high standards of energy efficiency and renewable energy usage is a key element of delivering reductions in London's CO_2 emissions.

Although improvements to existing building stock will contribute greater emissions savings over the next twenty years, new buildings will be around for many decades and will form an increasing proportion of London's building stock. It is estimated that one third of the homes standing in the UK in 2050 will have been built between now and then. The improvements outlined below will therefore be increasingly important to helping London sustain a low-carbon position. London, through the Mayor and boroughs, is well placed to lead the way in setting standards for other local authorities around the UK and beyond.

Better design of new homes is also essential for the wellbeing of all Londoners and the growth prospects of our city. Our vision for London is that of a sustainable and exemplary world city, a healthy, attractive and well-designed city capable of accommodating continuous growth in jobs and population over the next decade and mitigating (and adapting to) climate change.

As energy prices rise, new developments that are more energy efficient, whether residential or commercial, will become more attractive to tenants, who will give more consideration to levels of thermal comfort and energy bills. As people become steadily more concerned about climate change, so tenants in 'green' buildings can also be assured as to the lower environmental impact of their homes and premises.

Advanced design standards in other parts of the world such as Hammarby Sjöstad in Stockholm show that new developments can be designed to be attractive and consume less energy, without any dramatic increases in construction costs.

Hammarby Sjöstad

Hammarby Sjöstad is a new district on the waterfront in the centre of Stockholm, which offers housing for some 30,000 residents. From the outset, high environmental standards were imposed on the buildings' design by Stockholm City government, infrastructure solutions and traffic environment. The innovative solutions adopted at Hammarby Sjöstad include eco-friendly construction materials, solar panels and solar cells, green roofs, a vacuum system for solid waste and refuse sorting, storm water drainage, a waste water treatment plant producing biogas, a new tram, ferry traffic and car pools. (www.hammarbysjostad.se/inenglish/pdf/Best_env_eng.pdf). CO_2 emissions are estimated to be around 65 per cent lower than in other Stockholm areas – and Swedish standards are already the highest in the world.

Improved design standards will also be key to ensure that new buildings are appropriate for adapting to climate change. Buildings of the future will have to cope with different conditions, including greater needs for cooling as summer temperatures increase. This will be particularly pronounced in large cities like London, where the urban heat island effect can lead to temperatures of up to nine degrees Celsius warmer than in the surrounding green belt on a summer's night[1]. Buildings will therefore have to be designed to be comfortable in summer without greater consumption of expensive and carbon-intensive fossil fuels.

The rest of this chapter covers

- Current and projected CO_2 emissions from London's new developments
- Specific features of London's building stock and development

- Summary of potential actions to make new developments more energy efficient
- Actions already underway to tackle emissions from London's new developments
- The Mayor's key priorities for action.

4.3.2 Current and projected CO_2 emissions from London's new developments

Current emissions

There are currently 3.1 million dwellings in London and around 110 million square metres of commercial and industrial floor-space. London's 3.1 million dwellings account for 16.7 million tonnes of CO_2 while London's commercial sector currently emits 17.9 million tonnes of CO_2 per annum.

Future emissions

The London Plan projects significant growth in both the domestic and commercial sectors to 2025[2]. If new stock is built at current levels of CO_2 emissions (ie, as per the business as usual scenario), this could lead to an increase in CO_2 emissions of around 5.1 million tonnes per annum in 2025.

Sectoral target

Taking the target of a 60 per cent reduction by 2025 from the 1990 baseline, domestic and commercial new build would need to emit 1.8 million tonnes less CO_2 per annum by 2025. Achieving this reduction will be extremely challenging, realistically requiring the establishment of a carbon pricing system and further EU and UK legislation. However, recent developments in national planning and building regulations and London-specific guidance through the London Plan are intended to ensure that new build will be at least 30 per cent, if not 50 per cent, more energy efficient than London's existing building stock. The key issue will be ensuring that these improvements are realised through adequate information about and enforcement of the improved standards. We estimate that London could save around 1 million tonnes of CO_2 p.a. in 2025 against the business as usual scenario.

4.3.3 Specific features of London's building stock and development

London currently has the highest energy-efficiency standards of any city in the UK and is at the forefront of low- and zero-carbon developments. Realising the maximum CO_2 savings from new build development will however be challenging, particularly given the number of organisations involved and the need to ensure that improved standards are actually implemented.

The highest standards of any city in the UK

Published by the Mayor in 2004, the groundbreaking London Plan put London at the forefront of UK authorities by setting very high energy-efficiency standards for new build developments in London. The draft Further Alterations to the London Plan, due to be adopted and published in early 2008, raise these standards even further.

The current London Plan requires new developments to make the fullest contribution to the mitigation of and adaptation to climate change by incorporating energy efficiency and renewable energy measures, targeting in particular heating and cooling systems within developments. Developments are expected to reduce their energy needs in the first instance and then supply that energy efficiently with a proportion from renewable sources. There is an expectation for these issues to be tackled as early as possible in the development process, which creates the opportunity for innovative design. It also helps to ensure technologies are not designed-out too early.

The draft Further Alterations to the London Plan aim to secure energy considerations as a key part of the development process, setting a framework towards achieving decentralised energy in London to meet London's CO_2 reduction targets. The key proposed objectives for all new developments are as follows:

1 Minimise CO_2 emissions,
2 Adopt sustainable design and construction measures, and
3 Prioritise decentralised energy.

To guide decision-making and the consideration of development proposals, an energy hierarchy states that essential energy needs should be met through applying in sequence the following factors:

- using less energy
- supplying energy efficiently
- using renewable energy.

In particular, developments would be required to demonstrate that their heating, cooling and power systems have been selected to minimise CO_2 emissions and are consistent with decentralised energy technologies. The need for active cooling systems, for example, should be reduced as far as possible through passive design including ventilation, appropriate use of thermal mass, external summer shading and vegetation on and adjacent to developments.

The heating and cooling infrastructure should also be designed to allow the use of decentralised energy (including renewable generation) and for it to be maximised in the future. Developments should focus on delivering district heating, combined cooling, heat and power (CCHP) or combined heat and power (CHP).

As well as providing more efficient heating, such systems will allow buildings to be cooled in summer using vastly less energy, and without the greenhouse gas emissions created by refrigerants in conventional air conditioning. This is one of the areas where mitigation of and adaptation to climate change come together.

The current London Plan built upon the experience of the London borough of Merton[3] and required that 10 per cent of energy demand should be met through on-site renewables. The draft Further Alterations to the London Plan[4] go one step further by specifically requiring new developments to have energy supplied by CCHP wherever feasible and to reduce their CO_2 emissions by a further 20 per cent through the production of onsite renewable energy generation. This will drive energy efficiency in new buildings to go beyond national building regulations.

The Mayor's policies have proved to be highly successful in reducing energy consumption and CO_2 emissions, with overall savings of around 210,000 tonnes/year (ie a saving of approximately 28 per cent) since the publication of the London Plan in 2004.

London buildings at the cutting edge

London has traditionally been one of the locations for new and leading-edge building-design in the UK and has set the agenda on low and zero carbon developments. Zero carbon developments achieve zero net CO_2 emissions from energy use onsite on an annual basis, and low carbon developments a reduction of 50 per cent or more. This encompasses all energy uses of buildings and structures, eg cooking, washing and electronic appliances, heating, cooling, ventilation, lighting and hot water and is achieved through improved design, energy efficiency measures, efficient supply options and renewable energy technologies.

Past examples include St Matthews key worker homes in the London borough of Lambeth (low carbon, low cost housing), BedZED in the London borough of Sutton and BowZED in the London borough of Tower Hamlets, which aims at producing as much energy from renewable sources over the course of a year as it imports from the mains. Projects in development include Karma House in the London borough of Brent (energy efficient hotel) and Packet Boat House in the London borough of

Hillingdon, which aims at zero overall carbon emissions. These new projects will draw upon lessons learnt from previous developments.

Leading the way in low-carbon development is a natural evolution for London's community of architects, designers, developers, and builders, as highlighted by the four pilot Energy Action Areas in Wembley, Southwark, Merton and Barking (see box). This will position London's new developers well for similar developments in other parts of the UK and Europe. London will also work with neighbouring local and regional authorities, in areas such as Thames Gateway, the largest urban development initiative in Europe stretching from Tower Bridge through east London out to the Thames estuary.

Energy Action Areas

Four pilot Energy Action Areas (EAAs) have been designated in London to showcase the Mayor's energy objectives - New Wembley, Merton, Barking town centre and the Southwark pilot that includes Elephant & Castle regeneration and the Southwark Concerto community.

EEAs are neighbourhoods or regeneration areas that show what carbon reductions can be delivered on brownfield land in an urban environment. A number of elements are common across the areas (e.g. use of local heat distribution networks, small scale CHP, renewable technologies, carbon reduction and green procurement processes), but each area also has unique characteristics in terms of the technical, financial or partnership approach adopted. Examples of these unique approaches include the collection of organic waste from 10,000 households in the Southwark Concerto community to be treated through anaerobic digestion. Anaerobic digestion is a naturally occurring process of decomposition and decay, by which organic waste is broken down to its simpler chemical components under anaerobic conditions, i.e. without oxygen. The biogas produced through anaerobic digestion is distributed back to the same households through a biogas CHP community heating network.

EEAs must meet a number of criteria including:

- exceeding all current planning guidance relating to energy and sustainable construction, including complying with the London Plan energy hierarchy,
- considering activities related to the main development, such as transport, food or waste, which can significantly reduce CO_2 emissions,
- deliverability.

These pilot projects are expected to deliver carbon savings of 40-75 per cent. Further EAAs will be created over time.

Further information is available from the London Energy Partnership at www.lep.org.uk/

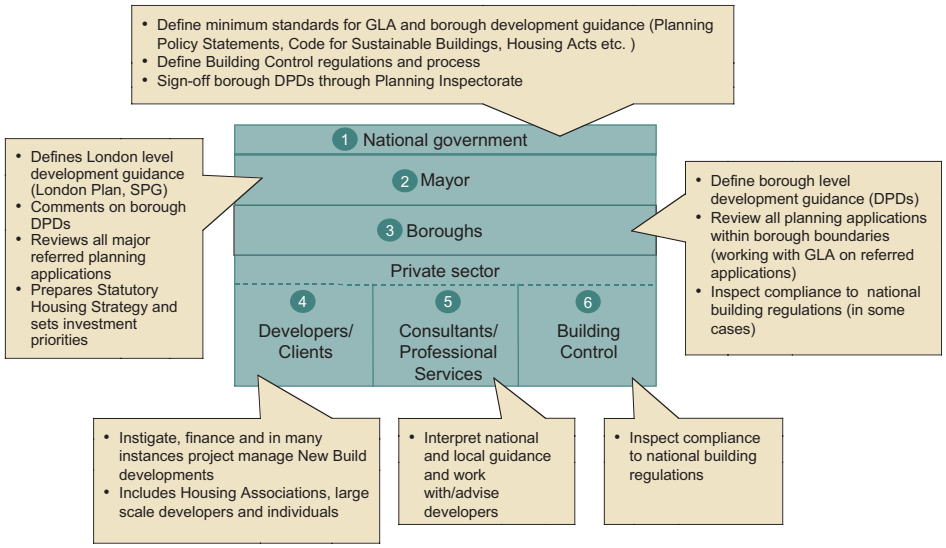
Case study: Southwark Concerto Community Project

The Southwark Concerto Community Project aims to reduce CO_2 emissions by 75 per cent by using a wide range of innovative technologies including wind turbines, biofuels and combined heat and power. It will retrofit existing housing and develop new homes, office space and a zero-emission environmental education centre.

A number of organisations are involved in planning and building control in London

There are six key stakeholders involved in new development in London: national government, the Mayor, boroughs, developers/ clients, consultants/ professional service providers, and building control. Each stakeholder has different areas of influence responsibility and opportunity in relation to capturing new build CO_2 savings.

Figure 40 Six key stakeholders in the context of reducing CO_2 emissions from new build



Source GLA

National government sets national standards in planning, building regulations and Building Control processes. These define the minimum standards for local government (GLA and the boroughs). Government is responsible for implementing EU legislation such as the European Performance of Buildings Directive (EPBD), which requires all buildings to be certified according to their level of energy efficiency from 2007. Government also signs off borough Development Plan Documents (DPDs) through its Planning Inspectorate.

The Mayor defines additional, London-level planning guidance through the London Plan (at the strategic level) and Supplementary Planning Guidance documents (SPGs), which support and explain the London Plan. It also requires energy efficiency measures above national building regulations, district heating/cooling and CCHP where possible, and specifies targets for the percentage of energy consumed to be generated from renewables, currently 10 per cent but set to increase to 20 per cent in the draft Further Alterations to the London Plan. In general, the revised London Plan will include policies to ensure new developments minimise their contribution to climate change, by minimising CO_2 emissions, adopting sustainable design and construction and prioritising decentralised energy.

The Mayor also provides input to borough-level planning guidance through its assessment of borough Development Plan Documents (DPDs),

to ensure they conform to the London Plan. Following the recent review of the Mayor's powers, this assessment will now serve as the starting point for the national Planning Inspectorate to examine and ultimately approve or decline the borough development plans.

The Mayor directly reviews strategically significant planning applications. The boroughs are required to refer certain applications (including individual developments over a certain size) for Mayoral approval. These applications typically number 300 per year, less than one per cent of the 87,000 applications made per year in London. However, due to their scale, referred applications represent a significant proportion of new developments.

Finally, through the LDA and in collaboration with developers, the GLA group promotes low and zero carbon developments on its own land. As part of these developments, the London Climate Change Agency and its joint venture with EDF, the London ESCO (Energy Services Company) will support the implementation of low and zero carbon energy technologies in these new developments.

Following the Government's review of the Mayor's powers, the Mayor has been given powers to recommend to Government how London's Regional Housing Pot will be allocated (roughly £1.7bn per annum). Once enabling legislation for the new powers is passed, the Mayor will produce a statutory housing strategy, a Strategic Housing Investment Plan, and will be able to make decisions over the broad allocation of funds for affordable housing. These powers will substantially improve his influence over improvements to energy efficiency in new and redeveloped affordable homes.

The boroughs set borough-level planning policy through their Development Plan Documents (DPDs). The DPDs must at least be in general conformity with the Mayor's London Plan and follow national planning policy.

All planning applications in London are initially made to the boroughs, who can then grant or refuse planning permission in line with local and regional planning policy. In deciding on applications - of which there are over 87,000 each year - the boroughs will have a significant impact on new build standards achieved across London.

Finally, boroughs carry out building control functions (described in more detail below). This activity has been privatised; typically, some building control resource now remains in the boroughs, although the majority of

the work is carried out by the private sector. The boroughs tend to handle smaller projects directly; large developers tend to use private sector building control services.

Developers and clients initiate, finance and often project-manage new development. This includes housing associations, large-scale developers and individual clients. These parties will be key players in delivering CO_2 reductions, since they define and monitor the specification of new buildings.

Consultants and professional service providers interpret national and local guidance and work with developers to build new developments. They keep developers up to date regarding continually emerging new energy technologies and can therefore play an important role in helping to deliver lower-carbon construction.

Building Control provides inspections of compliance with national building regulations; this does *not* include review of compliance with planning regulations. Part L is the key section for energy efficiency since it refers to the conservation of fuel and power. Part L was recently updated (April 2006) and requires reasonable provision to limit heat losses; provide and commission energy efficient building services; and provide building owners with information about efficient building operations. It also specifies maximum allowable annual CO_2 emissions.

The main barriers to implementation

Although there is growing interest in energy-efficient design and construction, and in the increased use of renewable energy, there are still numerous barriers that often make implementation difficult. These include:

- **Limited focus on CO_2 mitigation within local authorities.** Given the range of issues covered by local authorities, CO_2 reduction is often not at the top of the authority's agenda. This is partly because government does not require reporting on CO_2 emissions at local authority level; it is not included in national government's Comprehensive Performance Assessment (CPA) of the authorities' activities.
- **Limited planning capacity on CO_2/energy issues.** In many local authorities there is insufficient resource and skills on energy issues in the planning functions. The planning function is often understaffed and in some cases inadequately trained or provided with technical support, due to resource constraints. High turnover in planning staff

exacerbates this problem. This is a key issue given that boroughs handle over 99 per cent of London's planning applications.

- **Enforcement of planning and building regulations.** Resource constraints also affect enforcement: planning applications may be approved but may not be constructed to the agreed standard. This requires resource to identify and pursue, but implementation of planning policies are not monitored or enforced by borough or private Building Control services. Enforcement of building regulations in general - and Part L in particular - is very weak. The government has not yet made energy efficiency a priority for Building Control.
- **Different standards.** One challenge for enforcement is that different local and regional authorities will have different planning standards and levels of enforcement, which can cause confusion. It also creates additional administrative costs for the industry to comply and to stay abreast of changing regulations in different areas.
- **Cost of compliance perceived to be high.** Delivering energy-efficient new buildings that employ renewable sources of energy is perceived to be substantially higher cost than building to traditional standards. Many of these measures do not cost more, or are low cost to implement. In most cases, the measures also save the new tenant money in operating the building. Nevertheless, concern over cost is constraining implementation of these measures at present.
- **UK standards not as high as in other countries.** The UK's standards and regulations regarding energy in new build are less stringent than in other parts of the world and compared to many other European countries. Part L, for example, is not as strict in the UK as it is in other European countries. A Defra report comparing UK and best international energy standards as at February 2005[5] compared domestic heating demand reduction standards around the world and found that Sweden had set the highest standards, around twice as high as the equivalent UK standards. This suggests an opportunity for the UK to build up skills from best practice in other markets.

4.3.4 Summary of potential actions to make new developments more energy efficient

Ensuring future developments meet the highest standards of sustainable design and construction requires action at different levels:

- At national and European level, ensure effective enforcement of current regulations (in particular by raising the profile of energy-efficiency issues in boroughs and making energy-efficiency a priority for Building Control) and impose stricter regulations to ensure compliance with our CO_2 emissions reduction targets.

- At mayoral level, define London-specific planning and standards, implement them on applications referred to the Mayor as well as developments the LDA is involved in and new affordable homes, ensure conformity of borough policies and efficient coordination of all key stakeholders.
- At borough level, increase understanding of climate change issues and make it a key priority when reviewing planning applications and inspecting compliance with building regulations
- At industry level (developers, builders, clients, consultants, professional services), clarify understanding of existing regulations and ongoing changes
- At general public level, increase sensitisation to the benefits of energy efficiency.

4.3.5 Actions already underway to tackle CO_2 emissions from New Build

National and international level

A number of initiatives are underway to improve energy efficiency and reduce CO_2 emissions from UK buildings.

Initiative	Description	Lead	Status
Guidance and Documentation			
Building regulations	Regulations covering the conservation of fuel and power in new dwellings (L1A) and in new buildings other than dwellings (L2A); technical provisions are to deliver improvements of over 20% in new buildings	DCLG	Updated 2006
Code for Sustainable Homes	Voluntary initiative (mandatory where public funds are involved) to actively promote the transformation of the building industry towards more sustainable practices, ranking all homes based on sustainability standards	DCLG	Code for Sustainable Homes launched in December 2006; full Technical Guidance to be published in April 2007
Planning Policy Statement: Planning and Climate Change; Supplement to Planning Policy Statement 1	Sets out the need for stronger action to improve resource efficiency, reduce emissions and reduce vulnerability to climate change impacts	DCLG	Draft published in December 2006; consultation ends on 8 March 2007
Building a Greener Future: Towards Zero Carbon Development	Sets out the government's views on the importance of moving towards zero carbon in new housing. Proposes a timetable for revising the Building Regulations so as to reach zero carbon development in all new housing in England & Wales by 2016.		Draft published in December 2006; Consultation ends on 8 March 2007
Housing Act	Sets target which requires the Secretary of State to take reasonable steps to improve total residential energy efficiency by at least 20% by 2010, from a 2000 year baseline	DCLG	Published 2004
Energy Performance of Buildings Directive (EPBD)	Lays down requirements including calculation methodology of energy performance of buildings and application of minimum energy performance requirements for new buildings	European Parliament	Published 2003; to be implemented in the UK from 2007

London level

A number of studies and initiatives are underway to deliver carbon dioxide savings in London. These include a combination of guidance documents, toolkits, and training.

Initiative	Description	Lead	Status
Guidance and Documentation			
London Plan	Sets out key requirements for all new developments, over and above national Building Regulations.	GLA	Published 2004, Further alterations to be adopted early 2008
Low Carbon Designer	Zero and low carbon toolkit, to include supporting information for incorporation of sustainability considerations in building design	GLA/LEP	In progress
Renewable Energy Toolkit	Overview of renewable energy technologies, costs and planning requirements	GLA	Published 2004
Sustainable Design and Construction SPG	Materials to explain principles of sustainable design and implementation of London Plan	GLA	Published 2006
Towards Zero Carbon Developments	Supporting information on developing one zero carbon development per borough by 2010	GLA/LEP	Published 2006
Renewable Energy Information	Information for housing associations, Architects, Construction Industry and Estate Agents on incorporating renewable energy into developments	GLA	Published 2004
Training and Skills			
Skills and jobs from renewable energy	Assessment of skills in renewable energy and identification of future employment potential, training and engagement	GLA/ LEP	Published 2004
Sustainable energy training	Local authority pilot project of training sessions and supporting programme on energy efficiency and renewable energy	GLA/ LEP	Pilot project 2004
Projects on the ground			
Energy Action Areas (EAAs)	Five geographical areas piloting a range of energy efficiency and supply measures for potential rollout to broader areas	GLA / LEP	In progress
Zero and low carbon developments	Work with partners towards low and zero carbon developments throughout London, e.g., Gallions Park , Olympics and Paralympics projects	GLA/LDA/ LCCA	In progress
London Energy Services Company (ESCO)	Development of a public/private joint venture company between the LCCA and EDF to provide energy services and ensure emissions reductions	LDA/ LCCA	In progress

4.3.6 The Mayor's key priorities for action

The Mayor has varying ability to influence the challenges outlined above, so will need to focus on different areas with different kinds of effort to achieve CO_2 reductions. Over £1m of additional budget will be allocated to the initiatives below in 2007/08.

Figure 41 Mayoral group ability to influence new build issues

a To revise the London Plan requirements for new developments

The draft Further Alterations to the London Plan, due to be adopted and published in early 2008, requires new developments to minimise CO_2 emissions, adopt sustainable design and construction measures and prioritise the use of decentralised energy supply, most importantly connecting to combined cooling, heat and power (CCHP) networks.

b Greater emphasis on energy and planning at City Hall

We will be adding additional staff to the Mayor's Planning Decisions Unit and Environment team. These resources will focus on assessing the energy component of referred applications, reviewing borough development plans and producing assessment statements of conformity, supporting London Development Agency developments to ensure they are as low carbon as possible, as well as supporting the initiatives detailed below.

A review conducted by the South Bank University in July 2006 showed that the Mayor's London Plan requirements which came into force in 2004 had had a significant effect on CO_2 emissions, even with minimal resources to enforce them. The recruitment of just two dedicated and knowledgeable staff to enforce energy requirements in every planning

application that came before the Mayor resulted in further energy savings, almost tripling the renewables content of each development.

In addition, the London Climate Change Agency will continue providing advice to the Mayor's Environment team and the London Development Agency.

c A greater focus on energy efficiency at borough level

We will establish a comprehensive Outreach Programme to support boroughs and developers and other key stakeholders in their day to day operations. The primary cause of lack of focus, insufficient capacity and concern over costs is a lack of understanding of why and how to implement the increasingly stringent new build requirements. The current confusion is evident in the wide variation in completion standards of the Mayor's energy statement within the planning application process. The Outreach Programme will address this through three key components:

An education, training and support programme for Borough planners. The programme will build on work already carried out by the London Energy Partnership and will cover:

- Development and dissemination of university and Continuing Professional Development (CPD) modules for university lecturers and trainers of planners
- In-house training for borough planners covering:
  - A general understanding of climate change and its implications
  - The key energy efficiency, low and zero carbon technologies and measures and their respective cost and benefits
  - How to apply European Union, national and London level guidance and policy in the planning application process, how they fit with their local policy and what tools are available to help them
  - Key arguments to use in negotiations
  - Encouraging and facilitating borough planning departments to draw on local energy expertise and share resources.

The initiative will also consider opportunities for the Mayor to embed climate change awareness and understanding in occupational training programmes, such as at the Royal Town Planning Institute.

A publicly accessible energy portal for London that clearly lays out or links to

- Key guidance and targets for developing in London
- Information on low carbon technologies, including case studies where they have been adopted successfully
- Toolkits and training programmes on sustainable construction
- A forum for the exchange of ideas and support.

Collaboration with developers to promote and share best practice through a series of planner and developer seminars and publication via the energy portal (already underway). The Government's analysis on this subject from a national perspective will be a key input to this work.

The Green Construction Project

The Green Construction Project aims at increasing the uptake of existing environmental technologies by the building trades and wider construction sector. It will have four strands to it:

- creating incentives for the adoption of existing environmental technologies and ensuring they are adopted through the specification of London Development Agency infrastructure projects
- providing easily accessible and reliable information that compares cost and efficacy of existing products and materials with low carbon impact and other environmental benefits
- organising on-site demonstration events for the construction industry
- training the workforce to install and work with low carbon products and materials.

d Showing by doing: Individual developments and new housing powers

We will use the Mayor's new housing powers to ensure all new developments in receipt of public subsidy are built to the highest energy efficiency standards possible.

The Mayor issued a consultation paper "Towards the Mayor's Housing Strategy" in November 2006, and will publish a draft Mayor's Housing Strategy and Strategic Housing Investment Plan in July 2007. The Mayor sees his new Housing Strategy as playing a key role in supporting his work on climate change.

The energy efficiency requirements for new London homes, as outlined in the London Plan, already exceed those set at national level. We intend to

continue leading the way in this field, and welcome the introduction of a new national standard for the design and construction of sustainable homes. The Code for Sustainable Homes builds upon EcoHomes in a number of ways, in particular by introducing minimum standards of energy and water efficiency for each sustainability rating.

We also support the government's plan to reduce CO_2 emissions in new developments by 25 per cent in 2010, 44 per cent in 2013 and to reach zero carbon development in all new housing in England and Wales by 2016. London will strive to achieve this goal by 2016.

In order to achieve these objectives in all homes regardless of tenure, the Mayor's first Strategic Housing Investment Plan will set guidelines to encourage exemplary levels of environmental performance and zero carbon developments. The Mayor will want to see these guidelines applied across the board in all new housing regarding of tenure.

Around £1.7 billion has been allocated to the affordable housing programme in London for the period 2006-2008, out of a total housing pot of £2.3 billion. It will now fall on the Mayor to decide how this public money is spent, how many affordable homes are built every year and to which energy efficiency standard.

To remedy the acute shortage of homes in London, the Mayor has set an overall target of 30,500 new homes per annum in the London Plan. The number of affordable homes built every year will have to rise significantly to reach 50 per cent of all new homes (up from around 33 per cent in 2006).

Exemplary energy-efficiency standards, including zero carbon developments, will be adopted for all new affordable housing. Any additional development costs are expected to be offset by future energy savings, for the benefit of all tenants, particularly the fuel poor.

Similarly, all London Development Agency developments will be developed to the highest standards of energy efficiency, building upon experiences such as the Gallions Park zero carbon development.

Case study: Gallions Park, Albert Basin

To stabilise London's carbon emissions at 60 per cent below 1990 levels by 2025 requires that new development will need to move from being low carbon to being zero carbon. Following a presentation on the Dongtan zero-carbon eco-city in Shanghai, the Mayor asked the London Development Agency (LDA) to develop a demonstration project in London.

The LDA selected a three-acre site at Gallions Park in the Albert Basin. It is anticipated that the selected development partner will build approximately 200 high quality new homes incorporating modern construction and energy technology to ensure that the development produces net zero carbon emissions overall.

Engineering and design consultants Arup, who are also helping deliver Dongtan, carried out a feasibility study. This confirmed that a zero carbon development on this difficult site is both commercially and technically possible. Tenders have been submitted for the site and a preferred development partner has recently been announced.

The LDA expects all subsequent phases of development in the Albert Basin to lead the way in terms of energy efficiency.

Case study: Dagenham Dock

Dagenham Dock is a prominently located industrial estate in east London that has historically suffered from substandard infrastructure and 'bad neighbour' uses. The London Development Agency (LDA) has acquired the private roads and is upgrading these to adoptable standard. It has also acquired 15 acres of land and, in conjunction with the London borough of Barking & Dagenham and other stakeholders, has been developing a vision for a world-leading Sustainable Industries Business Park (SIBP) for London.

The Park will have workspace units targeted at the environmental technology sector, such as value-added recycling operations and renewable energy companies. The Park will also be a showcase for sustainable and innovative industrial developments that can fill in significant supply-side gaps in London's green economy, boost London's green jobs and stimulate market demand for zero/low carbon and zero/low waste technologies, products and services.

Alongside the soon-to-be built plastics recycling plant, the LDA is now exploring opportunities to attract reprocessing and remanufacturing companies capable of re-using end-of-life vehicles, waste electronic and

electrical equipment, and other material waste streams. In addition, the Business Park would benefit from hosting companies capable of manufacturing and assembling solar photo-voltaic products and hydrogen fuel-cell systems.

The LDA is working closely with the London Thames Gateway Development Corporation to formulate proposals for the Park, fund the infrastructure improvements (including support from the European Regional Development Fund) and identify the ideal type of occupier that can help implement the London Climate Change Action Plan and take London's green economy to a higher level.

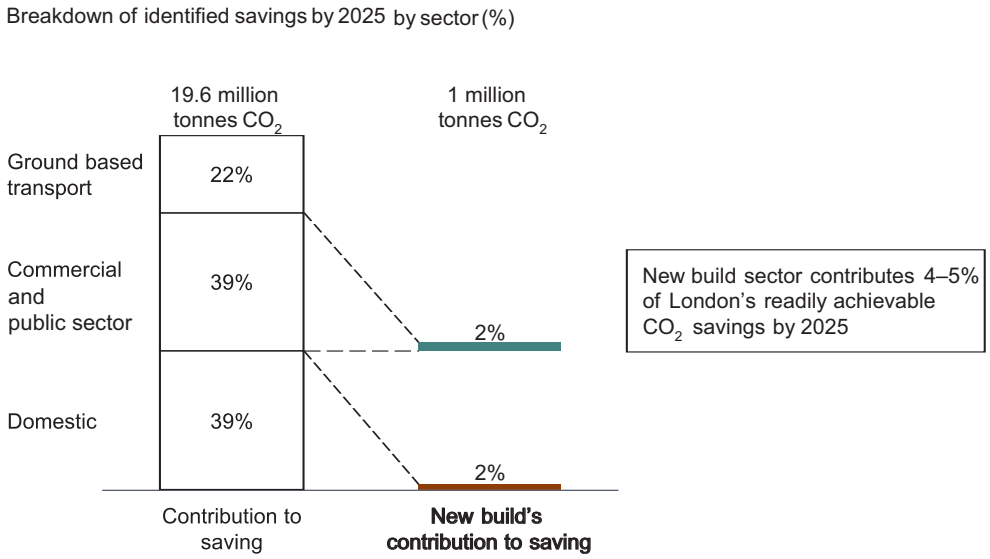
e Lobbying government

Finally, we will encourage government to:

- improve the enforcement of planning policy and building regulations. We will consider trialling a spot check approach on buildings during and after construction to monitor the degree to which energy related planning and building regulations are being adhered to
- amend the national planning guidelines to add an energy component in all applications, including non-referred applications
- remove barriers to the take up and roll out of decentralised energy (see Chapter 4.5 'Energy Supply')
- require the inclusion of energy statements in all planning applications (i.e. not just referred applications)
- push for CO_2 to become an integral part of the next version of the comprehensive performance assessment.

Successfully implemented, these mayoral initiatives will deliver CO_2 savings of around one million tonnes annually by 2025.

Figure 42 New build sector's contribution to CO_2 savings by 2025



References

1 London's Urban Heat Island: A summary for decision makers, Greater London Authority, October 2006.

2 The London Plan projects an increase in dwellings and office space of 0.8 per cent per annum to 2025. This translates into approximately 659,550 new dwellings by 2025, and 2.9m old ones left (as opposed to a total of 3.1m dwellings in 2005) , and 16.4m sq m of new office space, with 54m sq m of old office space left (compared to a total of 56.9m sq m office space in 2005).

3 The London borough of Merton was the first to formalise the Government's 2004 renewable energy targets by setting a target of 10 per cent of onsite renewable energy for all new major developments.

4 Public consultation on the Mayor's draft Further Alterations to the London Plan took place between 28 September and 22 December 2006. Adoption and publication are expected in early 2008.

5 Comparison of UK and best international energy standards as at February 2005, Report by the Market Transformation Programme, Defra, January 2006.

Barkantine Heat and Power Company (BHPC) is part of EDF Energy's generation portfolio and is a partnership between EDF Energy and London Borough of Tower Hamlets.

4.4 Emissions from energy supply

4.4.1 Overview

London's electricity and gas consumption causes emissions of 35 million tonnes of CO_2 per annum, 75 per cent of London's emissions. Only a relatively small amount of this energy is generated in London itself, less than 10 per cent of electricity and around 5 per cent of heat. Assuming the growth projected in the domestic, commercial and public sectors, this is to increase by 15 per cent by 2025 (compared to 2006 under the business as usual scenario).

Very significant reductions in carbon emissions can be achieved in London by changing the composition of its energy supply. Indeed, it will not be possible for London to achieve its carbon reduction targets without fundamental change to energy supply.

The Mayor's top priority for reducing carbon emissions is to move as much of London as possible away from reliance on the national grid and on to local, lower-carbon energy supply (decentralised energy, including combined cooling heat and power networks, energy from waste, and on-site renewable energy - such as solar panels). This approach is often termed 'decentralised energy'. The Mayor's goal is to enable 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.

However, to achieve emissions savings from decentralised energy requires vigorous and immediate action at both local and national level.

The Mayor's proposed draft Further Alterations to the London Plan sets targets for greatly increased decentralised energy supply and further introduction of renewable energy into London's developments. The London Climate Change Agency has been established by the Mayor to directly deliver decentralised energy supply through local combined cooling, heat and power networks and renewable energy sources including from waste and biomass.

The government has also set targets to reduce the carbon intensity of national grid electricity. The Mayor considers these to be insufficient and will be arguing for a greatly accelerated programme of developing renewable energy in the UK. The government's reform of planning regulations is also vital to remove the current barrier to large-scale renewable development.

How we can deliver substantial reductions in emissions from energy supply is detailed below, but includes:

- dramatically increasing the penetration of combined cooling heat and power (CCHP)
- demonstrating the potential of large-scale renewables, within the Greater London area. For example, non-building integrated wind turbines could generate enough electricity to supply 47,000 households and offshore wind in the Thames Estuary could supply a million homes
- demonstrating the potential of non-incinerated energy from waste/biomass to work towards delivery of the full potential of energy from waste/biomass which could supply electricity for up 1.2 million homes and heat for up to 375,000 homes
- lobbying government to remove barriers to the development of large-scale renewables and CCHP and renewable gases and liquid fuels.

The rest of this chapter covers

- Current and projected emissions from energy supply, including CO_2 reduction targets and an overview of key actions required to deliver the target
- Specific features of the energy supply
- Summary of potential actions to reduce CO_2 from energy supply
- Actions already underway to tackle emissions from energy supply
- The Mayor's key priorities for action.

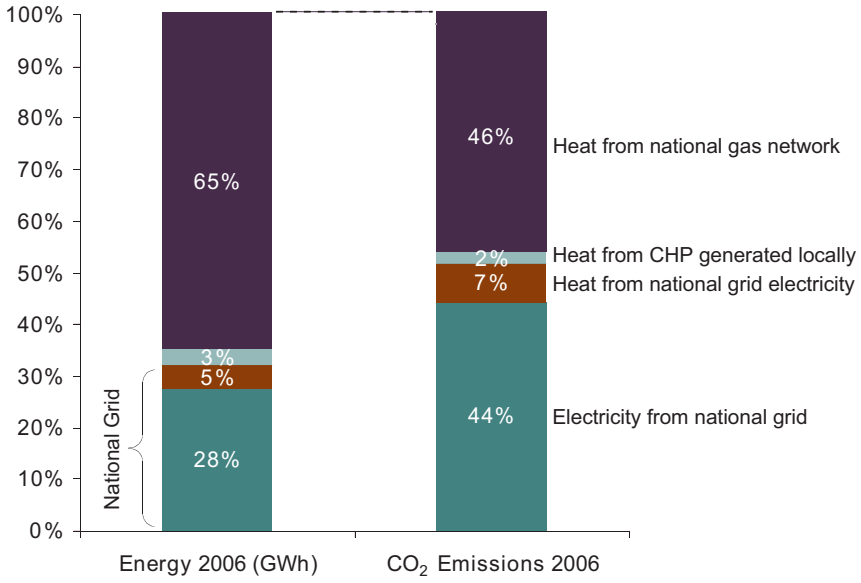
This chapter includes the CO_2 savings associated with energy supply to London's homes, London's commercial and industrial sites and to all London's new developments. It assumes that demand-side reductions in energy use in London's homes and commercial and industrial sites have already taken place.

4.4.2 Current and projected CO_2 emissions from energy supply

Current emissions

Sixty five per cent of the energy consumed in London today is in the form of heat supplied by the gas network and 32 per cent of energy is electricity from the national grid. Heat and electricity from CHP play a relatively minor role. Because the carbon intensity of grid electricity is higher than that of the gas heating network, electricity accounts for over half of CO_2 emissions from energy consumption.

Figure 43 London's energy supply and CO_2 emissions 2006
100% = 125,000 GWh; 34.7 mt CO_2



Source London Energy and CO_2 Emissions Inventory 2003; Powering London into the 21st Century, PB Power study for Mayor of London & Greenpeace, March 2006

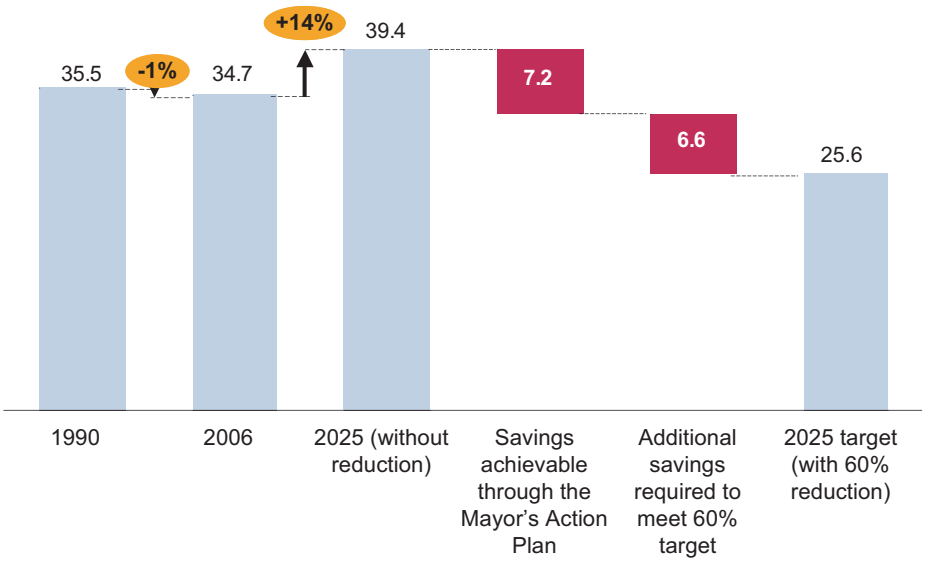
Future emissions (2025)

Without intervention, CO_2 emissions from London's energy supply are projected to rise to circa 39 million tonnes per annum by 2025 based on a business as usual scenario (an increase of 14 per cent), driven by the projected growth in both the number of dwellings and net energy consumption per capita.

Sectoral target

Taking the target of a 60 per cent reduction by 2025 from the 1990 baseline, energy supply would need to emit 13.8 million tonnes less CO_2 per annum by 2025. This means decentralised energy would need to meet 25 per cent of London's energy demand and radical reductions in the carbon intensity of the national grid would be required.

Figure 44 Supply - comparison of 2025 CO_2 emissions with and without 60 per cent reduction



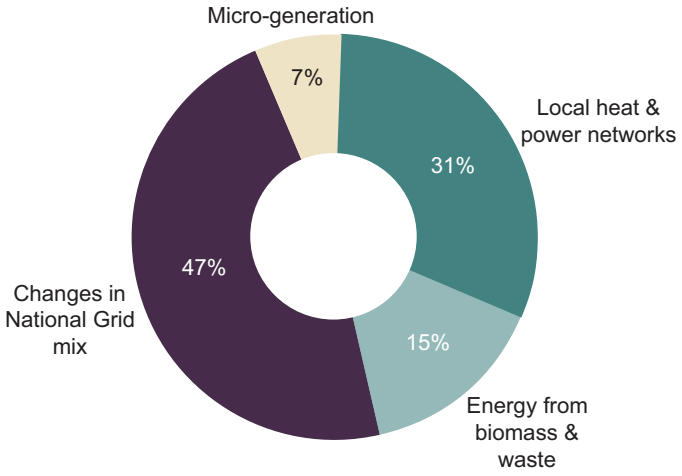
CO_2 reductions arising from changes in energy supply have been captured in the CO_2 savings footprint of the homes, commercial and development sector where the energy is consumed.

Achieving this reduction will be extremely challenging, realistically requiring the establishment of a carbon pricing system and further EU and UK legislation. However, in the current environment a saving of 7.2 million tonnes is achievable by 2025. This assumes the reductions in energy demand in the homes, commercial and industrial sectors described in sections 4.1, and 4.2 are delivered.

Overview of how the target can be achieved. Saving 7.2 million tonnes could be achieved through four key levers:

- an increased contribution from combined cooling, heat and power. CCHP generated in London would save 2.2 million tonnes of CO_2 per annum by 2025
- an increased contribution from energy from waste and biomass. Energy generated from waste and biomass using non-incineration based technologies and used to fuel biomass CCHP would save 1.1 million tonnes of CO_2 per annum by 2025
- an increased contribution from micro generation in London's homes and businesses including micro-wind and PV would save 0.5 million tonnes of CO_2 by 2025
- projected changes to the mix of fuel sources in the national grid, which includes the achievement of the Government's target of 20 per cent of energy from renewables sources, would save 3.4 million tonnes of CO_2 per annum by 2025.

Figure 45 Sources of CO_2 reduction from energy supply by 2025
100% = 7 million tonnes



Going further

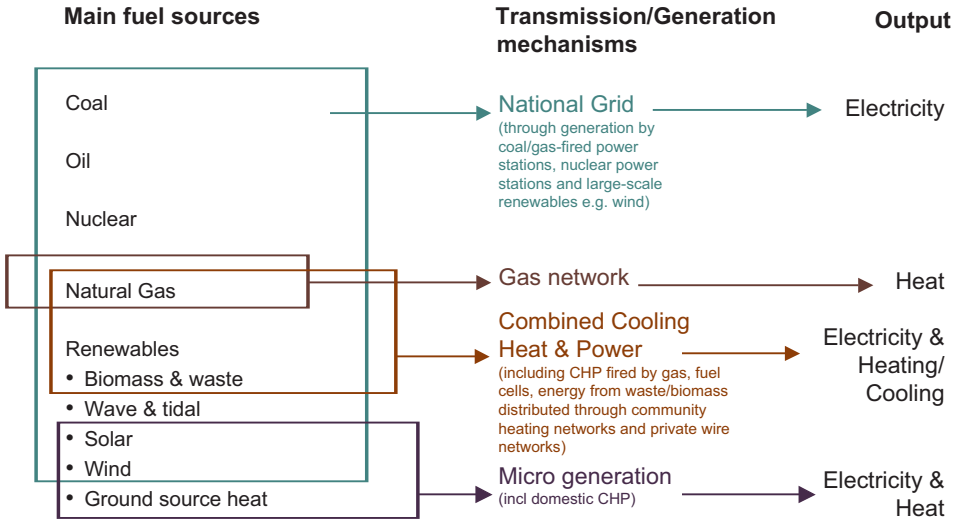
To achieve further reductions of CO_2 emissions, additional savings would need to be achieved by achieving much higher penetrations of combined cooling, heat and power and energy from biomass/waste, to achieve this, additional legislative and regulatory measures would need to be put in place to mandate the use of CCHP and to provide more control over waste.

4.4.3 Specific features of London's energy supply

Similarly to the UK, currently, one third of London's energy is comprised of electricity drawn from the national grid, and two thirds is heating supplied by gas from a national gas pipeline network. Hence London's energy supply therefore is best described by first looking at the UK perspective.

Energy generation in the UK uses a wide variety of fuel sources mainly coal and gas but also renewables such as wind, biomass and waste. Electricity and heat from these fuel sources are generated through a range of methods, including power stations, wind farms, combined cooling heat and power and micro-generation. Energy is then transmitted by four key mechanisms: the national grid, the gas pipeline network, community heating networks and private wire networks (for CCHP) and is supplied directly to homes/offices in the case of micro-generation.

Figure 46 Overview of the main components in energy supply



Centralised energy generation and distribution is inherently wasteful. The UK's system was designed in an era when stocks of fossil fuels were seen to be virtually infinite, prices were low and the impact of carbon emissions was not understood.

An average power station, be it coal, gas, oil, or nuclear, wastes around two thirds of its original energy input in the form of expelled steam created in the process of generating electricity. This has implications for water supplies as well as energy use, as nationally 50 per cent of all water use is for cooling centralised power stations. A typical 1,000MW power station consumes 2.5 million litres of water per hour, 80 per cent of which is directly evaporated into the atmosphere from power station cooling towers which dot the British countryside.

A further nine per cent of energy is lost in the process of distributing electricity from usually remote power stations to the cities and towns where it is primarily needed.

In contrast, generating electricity closer to where it will be used enables the heat that is created as a by-product to be harnessed and distributed to homes and offices, either to warm them or to power cooling systems. This process is commonly known as combined cooling, heat and power (CCHP).

London's highly density of population is well suited to CCHP (coupled with community heating and private wire networks) as they require high density to avoid losses during transmission of heat and mixed use developments, which tend to require a year round demand for heat and electricity.

Generally, London is less suited to large-scale renewables due to the topography and availability of space in London. There are however are some opportunities for wind installation and also opportunities to use London's significant purchasing power to encourage large-scale renewables outside of London.

Definitions

Decentralised energy

Decentralised energy (DE) is a collective term for all local energy generation close to the point of consumption as opposed to energy supplied from centralised supplies like the national grid.

Combined cooling, heat and power

Combined cooling, heat and power (CCHP) is a form of decentralised energy. CCHP enables the waste heat from the electricity generation to be captured and used for heating through Community Heating (CH) networks. Furthermore, this heat can be converted into cooling through absorption chillers. CCHP can therefore achieve far lower carbon emissions even if it uses conventional fuel sources - typically gas. Using CCHP to generate cooling provides additional CO_2 savings, as it replaces the conventional electricity-powered air conditioning that has a greater CO_2 intensity.

Energy from biomass/waste

There are many different definitions of both biomass and waste, and the two terms are not mutually exclusive. Biomass tends to refer to organic biodegradable matter including wood/forest waste, food waste, paper and card, and also energy crops. Waste is broadly defined as everything that is rejected as useless, unwanted, worthless or no longer required. London produces about 18 million tonnes of waste every year, approximately a quarter of this is municipal waste collected from homes and businesses, most of which is disposed of in landfill.

In accordance with the Mayor's waste strategy, there is a hierarchy for utilising waste, London must consider options to reduce and recycle prior to generating energy from waste. However, there is still significant opportunity to generate energy from the remaining waste, the majority of which is currently diverted to land fills sites. A series of non-incineration technologies can be utilised to transform the different types of biomass/waste into bio fuels including anaerobic digestion, pyrolysis, gasification and mechanical biological treatment.

The Mayor does not favour incineration as a method for generating energy from waste for a number of reasons. A large majority of incinerated waste can be reused, recycled or used to produce bio fuels

through non-incineration technologies. In order to be affordable, incinerators tend to be large and involve lengthy contracts and therefore reduce the incentives to recycle and increase the transportation of waste across London. Incinerators are inflexible as they cannot produce bio fuels for transportation and do not offer routes to produce renewable hydrogen. There is also continuing public concern about the emissions of heavy metals and dioxins.

The bio fuels produced from non-incineration technologies can be used to generate energy through CCHP, biomass boilers and co-firing with coal to reduce emissions from coal-fired power stations. The priority for waste-to-energy processing in London should be maximising the generation of renewable gases to generate electricity and the capture of heat generated in the process. This will also reduce the amount of waste sent to landfill sites and thereby avoid EU penalties for excess waste to landfill. Bio fuels can also be used for transport, and bio fuels are currently added to petrol and diesel as part of the government's renewable transport fuel obligation.

National Grid
The National Grid provides a centralised supply of electricity to the UK. The electricity of the national grid is generated from a variety of sources including power stations fuelled by coal, oil or gas, nuclear power and large-scale renewable energy.

Micro-generation
Micro-generation refers to small-scale on-site generation of electricity/heat from low or zero carbon sources. Micro-generation of heat can be achieved through solar thermal water heating, ground source heat pumps and biomass-powered water/room heaters. Micro-generation of electricity can be achieved through solar photovoltaic cells (PV) and micro-wind turbines. Domestic CCHP operates in the same way as other CCHP installations, but is designed for one home.

4.4.4 Summary of potential actions to reduce CO_2 emissions from energy supply

There are four main areas of energy supply that can reduce CO_2 emissions:

a using more energy generated locally through **combined cooling, heat and power**
b using more energy generated locally through **micro-generation**
c developing energy fuel from low carbon sources in particular **energy from biomass/waste**
d reducing the CO_2 intensity of **National Grid electricity**.

a Combined cooling, heat and power

CCHP enables the waste heat from the electricity generation to be captured and used for heating through community heating networks or converted into cooling. Generating both electricity and heating/cooling means CCHP is a more efficient source of generation (up to 85-90 per cent efficient in terms of the ratio of fuel input to energy output, compared to 35 per cent on average for centralised generation). In addition, as it is produced close to the source of use, there are fewer losses associated with distribution. Thus even when CCHP systems run on a fossil fuel, typically gas, they offer significant CO_2 emissions reductions compared with centralised power generation.

There are also benefits in terms of lower required investment in transmission and distribution systems, greater resilience of supply - particularly crucial for London's financial districts - and affordable warmth for more vulnerable households.

In the UK, Woking Borough Council implemented a series of decentralised energy projects between 1991/2 and 2003/4 that reduced CO_2 emissions by 142,000 tonnes, representing a 77 per cent saving from its municipal holding stock. Ninety three per cent of the Council's own energy supplies are derived from located decentralised energy systems (CHP, renewables and fuel cells).

Decentralised energy is widely used elsewhere in the world, most notably in Sweden and Denmark. Ninety six per cent of Copenhagen's buildings are connected to community heating systems, and CCHP supplies 40 per cent of Denmark's heat demand, with small-scale CCHP delivering close to 20 per cent of this.

The Mayor wants to replicate in London the success of Denmark and Sweden in implementing decentralised energy since the 1970s.

b Micro-generation

Micro-generation technologies are already available and functioning. 1.5 million tonnes of CO_2 p.a. could be saved by 2025 if 25 per cent of homes and new commercial buildings installed solar PV or micro-wind. Domestic CCHP technology is still developing but assuming the current technological barriers are overcome it could supply up to 18,000 dwellings in London by 2025.

Although micro-generation is perceived as an increasingly attractive option for homeowners and companies, its overall contribution to CO_2 reduction is still likely to be small.

However, to achieve London's long-term emissions stabilisation targets it is essential that we take every opportunity now to start embedding micro-generation. The Mayor's vision of London in 2050 is one where every building is fitted with some sort of micro-renewable generation.

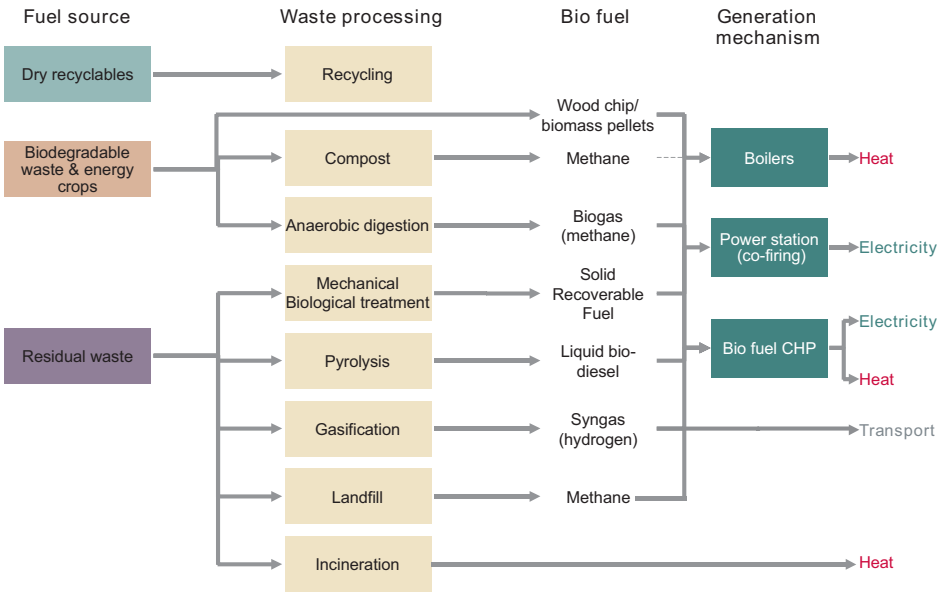
c Energy generated from non-incinerated biomass and waste

London has a huge and largely untapped opportunity to create renewable energy from waste. Both biodegradable waste and some residual waste can be used to generate bio and synthesis fuels. In accordance with the Mayor's waste strategy, there is a hierarchy for utilising waste, London must consider options to reduce and recycle prior to generating energy from waste. However, there is still significant opportunity to generate energy from the remaining waste, the majority of which is currently diverted to landfill sites. If all of this land filled waste were utilised in non-incineration technologies, it could enough electricity to power up to 1.2 million homes, and heat up to 375,000 homes.

Hydrogen generated from waste is particularly suitable for both buildings (as a fuel for CCHP) and as a transport fuel. More details on hydrogen as a transport fuel and the work undertaken by the London Hydrogen Partnership can be found in the section 4.5, Ground Transport.

Savings of up to 5.7 million tonnes of CO_2 could be achieved if all the residual biomass and waste currently directed to landfill were utilised for electricity and heat generation. This is a massive opportunity and the Mayor will direct new resources into realising it.

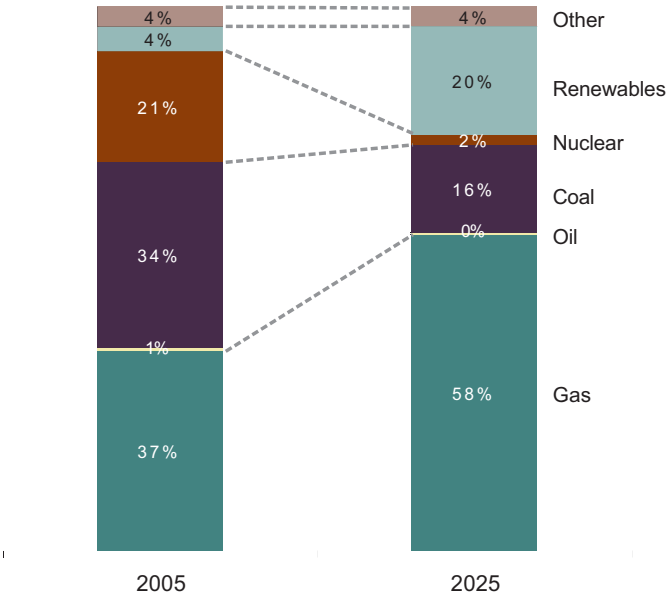
Figure 47 Processing waste/biomass to create energy



d The National Grid

The National Grid will contribute to London's CO_2 savings as the mix of fuel sources used to generate the grid electricity changes. The government is projecting an increased reliance on gas and renewables and a decrease in electricity generated by coal and nuclear power. Coal is nearly five times as carbon intensive as gas. Renewable energy sourced from bio fuels, wind and solar do not emit any CO_2. Currently the carbon intensity of the National Grid is 0.52 kg CO_2 per KWh. By 2025 under current Government policy, this could reduce by 20 per cent to 0.42 Kg CO_2 per KWh.

Figure 48 Projected changes in national grid mix



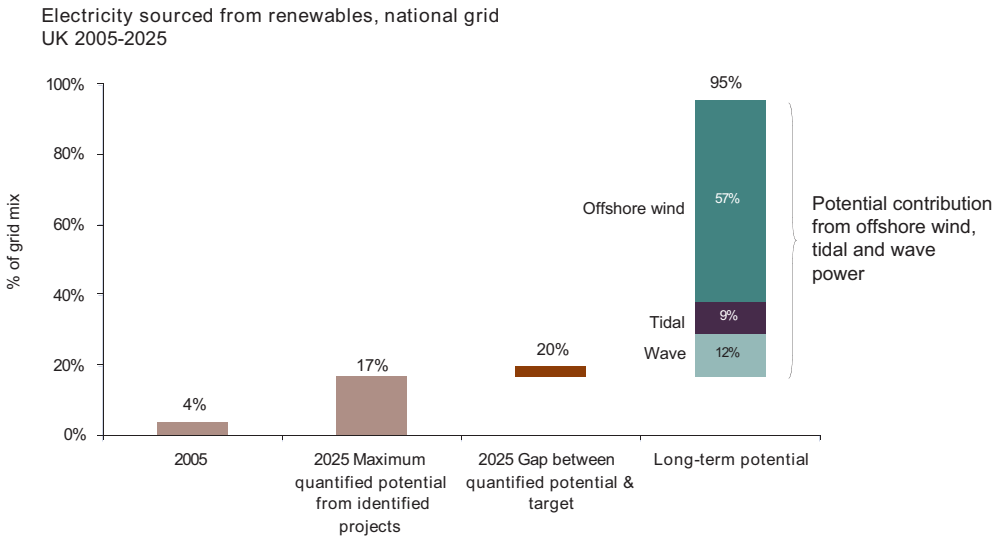
Key changes projected to the grid's CO_2 intensity include:

Renewables

The UK's record in taking advantage of the incredible opportunities for renewable energy that it enjoys as an island nation, surrounded by untapped wave and wind energy, has been undeniably woeful.

The government has set a target of 20 per cent of the national grid supply to be sourced from renewables by 2025. Current projects in planning stages could deliver most of this target. There is further significant potential from offshore wind and new technologies such as wave and tidal. In fact, some estimates suggest that renewables could provide nearly 100 per cent of the UK's electricity with offshore wind providing up to 60 per cent of the total.

Figure 49 Potential of wave, tidal and off-shore wind



Nuclear

The role of energy generated from nuclear power will diminish if the government's current plant decommissioning plans are delivered. However, the current Energy Review may result in new nuclear power stations to replace the decommissioned plants. Results of the review are expected in March 2007. The Mayor opposes new nuclear power stations and is concerned that an expensive nuclear programme will divert time and resources away from decentralised energy solutions that could more efficiently deliver the significant emissions reductions necessary over the next decades[1]. In addition, nuclear has a number of drawbacks including cost of development (construction of previous nuclear plants have required significant levels of government subsidy), environmental impact of uranium mining and complexity of waste disposal issues.

Carbon capture and storage

In its package of energy measures announced in January 2007, the EU confirmed its intention to proceed with mainstreaming of carbon capture and storage (CCS) technologies to reduce CO_2 emissions from coal fired power plant. These technologies could reduce CO_2 emissions from coal-fired power plants by 85-90 per cent. It is intended that by 2015 there should be 12 large CCS equipped installations across the EU, and for CCS to be in place on all coal fired power plant by 2020. Further recommendations in this area are in development by the European Commission.

While burying carbon emissions underground is not a long-term solution, the Mayor recognises that it is being investigated around the world and will offer significant emission reductions once commercially viable and the

UK is likely to be able to take advantage of carbon capture and storage while achieving a transition to a renewable energy based economy.

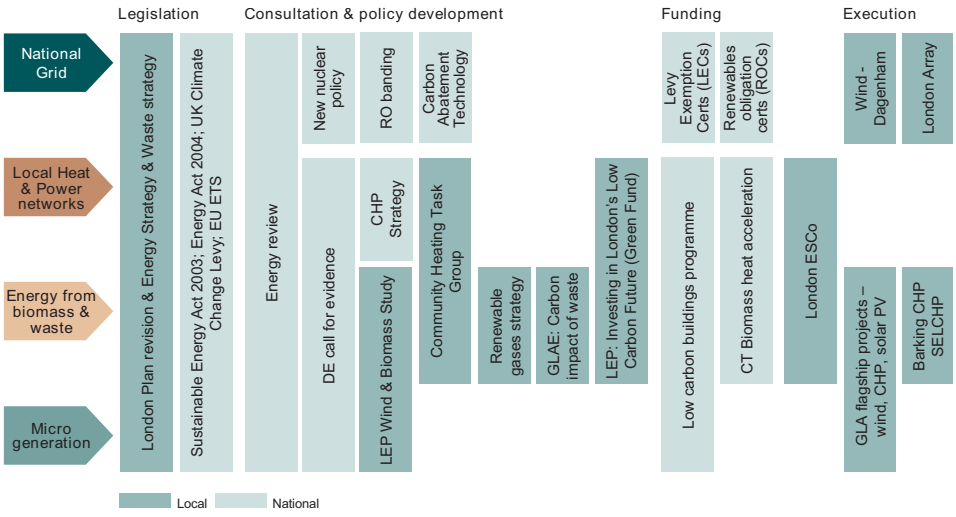
Gas

As a result of the trends away from coal and nuclear between now and 2025, the National Grid will become more heavily dependent on gas to generate electricity. UK supplies of gas are running out and by 2025 the Government projects that 80-90 per cent of gas will be imported, and this will require significant development of infrastructure. Security of gas supply is an important issue for the UK and government is increasingly focussed on electricity generating mechanisms that are not gas dependent.

4.4.5 Actions already underway to tackle emissions from energy supply

There is significant activity underway in London as well as nationally to reduce the carbon intensity of the energy supply. However, a greater focus on overcoming barriers to implementation of low/zero-carbon energy sources is critical.

Figure 50 Current landscape of existing initiatives reducing supply CO_2 emissions



A brief summary of some key initiatives follows.

National government

- Under the umbrella of the Energy Review, the Department of Trade and Industry (DTI) is consulting on changes to the Renewables Obligation to provide additional support through banding renewable technologies to enable continued support of established low/zero carbon technologies and additional support for less mature and emerging technologies such as off-shore wind, tidal and wave energy.

The Energy Review will also include the results of the DTI call for evidence review to assess the barriers and incentives associated with distributed energy.

- The Department of the Environment (Defra) is also consulting on measures to introduce carbon pricing into the large non-energy intensive public and commercial sectors (the Energy Performance Commitment)
- The government is also developing the second round of the European Union Emissions Trading Scheme that will allocate CO_2 emission allowances for the 2008-2012 trading period. This is a strong market mechanism for driving industry towards cleaner energy generating technologies and driving down emissions. The UK has agreed its overall emissions ceiling (National Allocation Plan) with the EU for this period.

The Mayor and the GLA Group

The Mayor is working in a number of areas to progress zero/low-carbon energy supply in London.

- The Mayor's groundbreaking London Plan (2004) put London at the forefront of UK authorities in using planning guidance to require more energy efficient new developments, including requiring that 10 per cent of energy demand should be met through on-site renewables.
- The Mayor has now published revisions to his London Plan, primarily in response to the growing threat of climate change. These set out a strict hierarchy for new developments, most importantly including that all major new developments should establish or connect to a local combined cooling, heat and power network. The revised Plan also raises the requirement for the proportion of on-site renewable energy to 20 per cent. These revisions are currently the subject of public consultation.
- The Mayor has established the London Climate Change Agency (LCCA) to implement high impact CO_2 reduction projects with a focus on decentralised energy. The LCCA has established a joint venture energy services company (London ESCo) with EDF Energy to develop and demonstrate sustainable energy schemes for London. The London ESCo will design, finance, build and operate local decentralised energy systems for both new and existing development. Projects already in the pipeline could deliver eight per cent of CCHP's potential in London.
- Ongoing research, involving the LCCA, the London Energy Partnership, the London Hydrogen Partnership and GLA, into opportunities for renewables in London including a renewable gases and liquid fuels strategy to guide future policy making on capturing energy from waste/biomass is also under development.
- Using the Mayoral Group buildings to test and showcase low carbon technologies, for example: wind turbines and solar PV, is in operation on Palestra (home to the London Development Agency); the London

Fire Authority (LFEPA) has completed a number of projects to install micro-renewable technologies at seven sites, including solar photovoltaic cells, solar water heating and CHP; solar photovoltaic cells have been installed on the refurbished London Transport Museum, and will soon be installed on City Hall.

London Climate Change Agency

The establishment of the London Climate Change Agency (LCCA) was a manifesto commitment by the Mayor in the 2004 election to transform London into a leading low carbon sustainable city. The Mayor launched the LCCA in 2005 with the support of the following founders: BP, Lafarge, Legal & General, Sir Robert McAlpine, Johnson Matthey, and the Corporation of London, as well as backing from the Rockerfeller Brothers Foundation, KPMG, Greenpeace, the Climate Group, the Carbon Trust and the Energy Savings Trust.

The LCCA is a direct delivery agency implementing projects in the sectors that impact on climate change, especially energy, transport, waste and water. Following its establishment the LCCA has been implementing a number of flagship projects, including renewable energy projects at the London Transport Museum, Palestra and City Hall. The LCCA has also established the joint venture energy services company London ESCO.

Nine major energy utilities, US and international energy companies submitted bids to become the private sector partner in the London ESCO. The London ESCo Ltd was established as a public/private joint venture Energy Services Company between London Climate Change Agency Ltd and EDF Energy (Projects) Ltd in September 2006.

Through the London ESCo the LCCA is pursuing involvement in the Gallions Park Zero Carbon development project, Dagenham Dock (including large scale wind farm and CCHP), and Silvertown Quays CCHP. Potential future projects include The Royals Business Park and St Andrews.

Challenges to increased decentralised energy in London

A number of large-scale Combined Heat and Power schemes are currently out to tender in London, including Combined Cooling Heat and Power schemes for the Elephant & Castle, Kings Cross central, new Wembley and the Olympics/Stratford City developments. Other CHP schemes are also being considered in London, including capturing the heat generated by Barking Power Station, Greenwich Tilfen land development and schemes in Croydon Town Centre and Heathrow Airport. There is also opportunity to capture heat generated by SELCHP waste to energy plant in Lewisham.

The London ESCO is working on a group of CHP and renewable energy projects that would double the current CHP capacity in London.

Overall, despite these initiatives, challenges remain across all four areas of London's potential CO_2 savings and much more will need to be done to achieve these savings.

Technology for **combined cooling, heat and power** (and community heating networks) has been available for many years, yet its current role in generating local energy is small. Whilst the London Energy Services Company (London ESCo) is leading the way more must be done to drive the penetration of CCHP across London:

- There is currently little incentive to overcome the cost and time implications of installing CCHP (including connecting to the grid). If a fair price were paid by the grid for the excess energy generated through CCHP the commercial feasibility would be improved. Electricity from the UK grid is sold at c. 9p/KWh. This contrasts with excess electricity that is bought by the grid for only c. 2p/KWh. In Germany, by comparison excess electricity can be sold to the grid at four times the cost of buying it from the grid. A fair price for excess electricity should be introduced, and the cost and time required to connect to the grid should be reduced.
- As an alternative to selling to the grid, a far better price for electricity generated by CHP could be obtained by supplying customers directly on private wire networks under the exempt licensing regime. However the exempt licensing regime limits the amount of power which can be supplied thereby limiting the potential of private wire networks.
- National planning regulations do not mandate CCHP in all appropriate developments. The Mayor has made effective use of his powers to mandate the inclusion of renewable energy and CCHP technology in developments of 500+ dwellings. However, CCHP and community heating networks are technically viable for mixed-use developments of 250+ dwellings. Boroughs make planning decisions on these developments in accordance with national planning regulations. National planning regulations should therefore be amended to require all developments to incorporate CCHP, or demonstrate why it is not feasible.
- Developers in London are experiencing problems in identifying organisations/ESCos to operate the CCHP once it is in place. Landlords, management companies or ESCos are unlikely to seek involvement unless the service can be profit making.
- There is also the problem that it is relatively easy to install CCHP in new developments, but far less so in existing building stock. The boroughs have opportunity to replace community heating boiler-run systems or

individual boilers in social housing with CCHP. However, under the current investment programme (Decent Homes element of the London Housing Strategy budget), decisions on the use of such funding are not required to look at a business or environmental case for alternative heating systems, to justify the type of heating installed. If they were, in the vast majority of cases a CCHP solution would be preferred.
- The government has committed to supply 15 per cent of Government departments with CCHP by 2010, but acknowledges that this target is unlikely to be met. More must be done to meet this target and additional aggressive targets should be set for public sector buildings in London to drive take-up and further demonstrate the commercial applicability of the technology.

Biomass and waste and new, non-incineration based technologies, such as anaerobic digestion and gasification/pyrolysis are common in Europe and the rest of the world, but are less prevalent in the UK. London is taking a leading role in the development of such technologies. Work is underway to understand which technologies have the least greenhouse gas impacts are the most appropriate for London but improved stakeholder coordination, more capital and stronger demand are required to realise the potential.

- The process for agreeing how to manage energy from waste in London involves a large number of stakeholders: each borough is responsible for its own waste collection, 12 boroughs dispose of waste themselves and a further 11 are arranged in four joint waste disposal authorities. Implementing a pan-London policy for waste, and for energy from waste is hampered by the lack of a single London waste authority.
- More financial support to encourage the development of new non-incineration technologies is required. For example, private finance initiative credits are available to help with the significant capital cost of building incinerators but are not available for the development of smaller-scale technologies such as anaerobic digestion, mechanical biological treatment, pyrolysis and gasification. The Mayor has produced guidance on procurement strategies for new technologies.
- Demand must be stimulated to drive the development of this area. For example, there is currently no bio fuel CCHP operating in London.

Improved planning regulations and more financial support is required to increase the volume of **renewable energy in the National Grid**.
For example,

- Developments are hindered by lengthy planning and consultation requirements. In some instances planning decisions have taken up to

three years to reach. Action should be taken to implement the Barker Review, welcoming proposals to have a presumption in planning guidelines that favour renewables infrastructure projects and zero-carbon/waste developments, whilst ensuring that local communities are fully involved in the planning and decision-making process.

- Incentives and funding for demonstration-stage projects on many renewable technologies, in particular wave and tidal, are not available currently. Incentives and funding must be increased, either through Renewables Obligation banding or via the introduction of other fiscal incentives. This financial support should cover not only the development of the electricity generating technologies, but also the development of infrastructure to link these technologies into the National Grid.

More practical information and support is needed for individuals to drive the penetration of **micro generation** in both the domestic and commercial sectors:

- Availability is improving as well known retailers are moving into the market, but practical installation information and support is severely lacking
- Whilst the cost and payback of these technologies declines, long-term grant support must be maintained to encourage take-up. In parallel, effort should be focused on driving the cost of these technologies down, particularly photo-voltaic cells.

4.4.6 The Mayor's key priorities for action

Many of the challenges relating to CO_2 savings from energy supply are beyond the immediate control of the Mayor. However the Mayor will establish a Low Carbon Supply Programme addressing four key components. This programme will seek to address as many of supply's key barriers as possible by working through agencies, partnerships and alliances, and by lobbying government directly.

a Increasing the penetration of CCHP across London

The Mayor's top priority for cutting carbon emissions from energy supply is to progressively move London away from reliance on the inefficient National Grid, and onto decentralised combined cooling, heat and power supply - which ultimately should run on renewable fuel sources.

This will be achieved in three key ways.

First, through the Mayor's planning powers over major developments in London. The Mayor has now published the draft Further Alteration to the London Plan, primarily in response to the growing threat of climate change. These set out a strict hierarchy for new developments, most importantly including that all major new developments should establish or connect to a local combined cooling, heat and power network. The revised plan also raises the requirement for the proportion of on-site renewable energy to 20 per cent. These revisions are currently the subject of public consultation.

These new regulations are projected to result in additional CCHP and onsite renewable energy capacity as set out in the table below.

Draft Further Alterations to the London Plan Table 4A.1i - Targets for installed renewable energy capacity (up to 2020)

		2020
	Number	Installed Capacity (MW)
Offshore wind farms[3]		
On-Shore wind farms[3]		
Single large turbines	18	45
Small stand-alone wind turbines	50	10
Building mounted micro-wind turbines	6000	15
Biomass fuelled CCHP / electricity	150	450
Biomass co-firing[1]		
Anaerobic digestion of farm biogas[3]		
Hydro power[3]		
Solar PV (domestic) (MWp)	21000	45
Solar PV (commercial) (MWp)	750	36
Tidal energy[3]		
Wave energy[3]		
Sewage gas	6	30
Thermal treatment of municipal / industrial waste	3	18
Total	28077	669

Second, the Mayor will use the London Climate Change Agency to deliver major CCHP projects across London. The LCCA has identified a pipeline of projects that will deliver CCHP capacity and implement both large and small scale renewable energy projects at an investment value in the range of £100 million.

The Climate Change Agency will not, however, be able to take advantage of all CCHP opportunities in London. It is hoped that its existence will catalyse action in the private sector and other ESCos will be established to meet rising demand for decentralised energy. The Mayor's London Energy Partnership Low Carbon Fund Task Group is investigating other potential partners for ESCos and the LEP Community Heating and CHP Task Group is seeking to secure partners and funding to stimulate activities to deliver community heating and CCHP.

Over time it is expected that CCHP and renewable investment will reach a level of £1-2 billion.

The Mayor will also establish a CCHP Promotion & Information team to drive and support projects outside the remit of the London ESCo. This team will identify and prioritise sites, particularly in existing building stock, and will work proactively with developer and borough planners to overcome implementation challenges and barriers. Ways to incentive take-up by householder will also be explored, including through Low Carbon Zones - where householders would be offered the opportunity to a subsidised package of energy efficiency measures in their home, if they signed up to having energy supplied by an energy service company (at a fixed, cheaper price).

Third, the Mayor will prioritise the use of combined heat power and cooling energy supply in developments taken forward by the London Development Agency, for example in the Thames Gateway, the largest urban development initiative in Europe stretching from Tower Bridge through east London out to the Thames estuary.

Investing in London's low carbon future

A recent study by the London Energy Partnership has identified substantial investment appetite to fund carbon reduction initiatives in London. As a result, a number of initiatives are under development to address funding for both medium/large-scale projects, and micro-generation and energy efficiency projects.

Funding for medium/large-scale projects

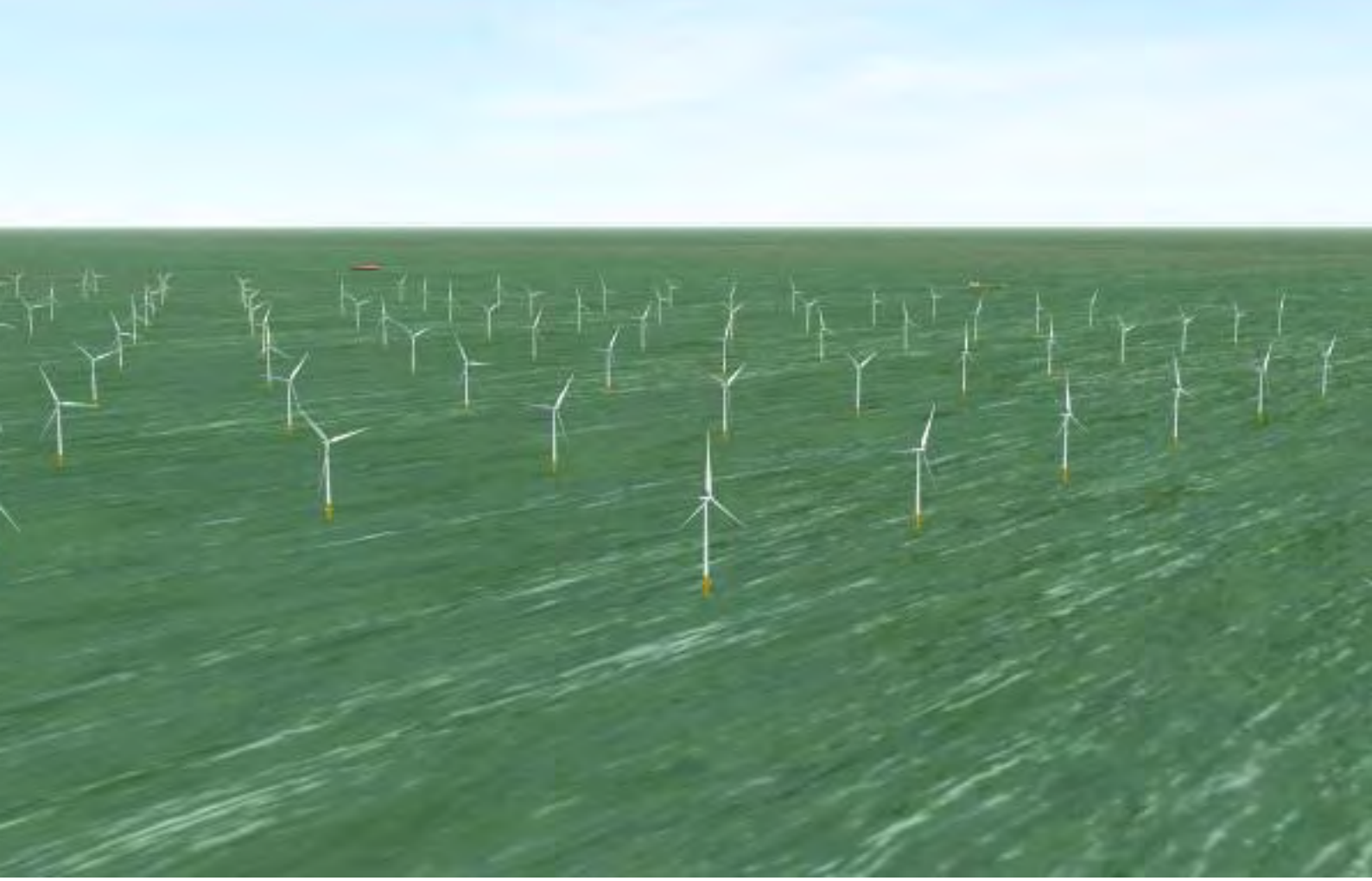
- Establishing a fully funded "Low Carbon Fund" for London comprising private and public sector funding to invest in standalone low carbon projects that are fully consented and planned. A portfolio of projects is currently under development and discussions are underway to define the structure of the funds and with the European Investment Bank to secure funding. A task group has been established to take this work forward, and to appoint an investment manager for the fund.
- A specialist advisory service is being established to assist small/new businesses in developing their business cases for low-carbon projects to ensure they contain the technical and financial detail required by banks to gain funding.

Funding for micro-generation and energy efficiency projects

- Developing a rental scheme/utility led ESCO - a special purpose vehicle to make the required capital investment in micro-generation and energy efficiency technologies, products and services in return for an ongoing rental stream payable by the consumer. Work is currently underway to identify an appropriate structure and to carry out market testing.
- Developing a buying co-operative or mutual - energy users join a co-operative or mutual organisation to provide low-cost services for the benefits of members through enhanced buyer power. Workshops are currently underway with public sector energy users, developer and housing associations to identify opportunities for co-operative development.

b Demonstrating the potential of large scale renewables

There are a number of potential sites for on-shore wind in London. Whilst they will not deliver a large proportion of London's electricity needs, the development of these sites will generate momentum for wind developments elsewhere. The Mayor will support these on-shore developments actively and will support the development of offshore wind in the Thames Estuary, including the London Array. The Mayor and his agencies will also consider new, innovative ways to encourage and support large-scale generation outside London.



Opportunities for large-scale wind installations in London
The London Energy Partnership recently looked at the potential for non-building integrated wind turbines in the Greater London area. Many of the potential development opportunities represent innovative siting opportunities and an opportunity to implement "iconic" developments, placing wind turbines in visible and accessible locations, developing familiarity with the technology.

The study identified a number of locations including Stratford Olympic Site, East Beckton, Dagenham Docks and East Rainham. In total they could generate 155 GWh of electricity from wind in the GLA area, enough to supply 47,000 households, and provides advice on the development of wind energy schemes when undertaking specific or strategic assessments of London's wind opportunities. The London Climate Change Agency (LCCA) has carried out a feasibility study for an 8MW on-shore wind energy scheme in conjunction with EDF Energy

Offshore wind in the Thames Estuary could a further supply 3,300 GWh of electricity, enough to supply a million homes. Together, these on- and off-shore wind turbines could supply 2.5 per cent of London's electricity in 2025 (under business as usual scenario).

c Demonstrating the potential of energy from waste/biomass

Energy from waste/biomass provides a huge opportunity for London. If all of the London waste that currently goes to landfill (where it emits greenhouse gases such as methane) were utilised, it could generate enough to provide electricity to up to two million homes, and heat up to 625,000 homes. The Mayor wants to unlock this potential.

This is an area, however, where technologies are still being developed and many alternatives mean further work is required to assess the most appropriate direction for London. This has to take into account the most appropriate waste processing technologies, the availability and location of waste/biomass, the level of CO_2 emissions, impacts on air quality impacts and our ability to implement. The Mayor's environment team and Climate Change Agency will work together to develop a renewable gases and liquid fuels strategy (see boxed text).

The Mayor's environment team are undertaking a study to determine the greenhouse gas impacts of different waste recovery technologies. The results of this research will be used to affect the revision of the Mayor's Municipal Waste Management Strategy, and help to develop a hierarchy of technologies.

Municipal waste represents less than a quarter of all waste produced in London, but London's businesses contribute over a third. Therefore the Mayor's environment team will work closely with the LCCA to develop proposals for utilising waste produced by London's businesses to help to develop new opportunity for new energy from waste technologies in London.

A CCHP & Waste/Biomass development programme will explore technology options, develop clear suggestions regarding rollout and promote a wider implementation of these technologies.

Renewable gases and liquid fuels strategy
The aim is to generate a renewable gases and liquid fuels supply chain from waste using non-incineration technologies including anaerobic digestion of organic waste and/or sewage producing biogas, and pyrolysis and gasification, of wood, paper, plastic, light industrial waste, producing synthetic diesel or synthesis gas (syngas). Typically, a new facility comprising commercially available anaerobic digestion plant and pyrolysis/gasification plant would be located at a waste collection site and immediately adjacent to local mixed development. The LCCA and London Remade has identified a number of waste sites across London and is working towards establishing agreements with waste stakeholders to develop this potential.

The renewable gases and liquid fuels will provide low carbon fuels for low and zero carbon developments and transport applications, and to supply non-potable water from waste dewatering (squeezing liquid out of waste). Local low and zero carbon developments will be supplied with heat and electricity from fuel cell or CCHP, distributed via a private wire and district-heating network, with local heat fired absorption chillers for chilled water services (where required).

Renewable fuels from waste could be the single largest form of indigenous renewable energy in London, and there are enough potential waste management sites in East London to supply the needs for low and zero carbon fuels of the projected new development in the Thames Gateway and the Lower Lea Valley where around 100,000 new homes are expected by 2016.

d Promoting micro-generation technologies

The Mayor will also support and promote micro-generation technologies through the Green Homes and Green Organisations programmes outlined in the domestic and commercial sector review chapters in this document.

e Lobbying government

Lobbying Government with regard to energy supply has two purposes, firstly to facilitate take-up of decentralised energy in London, and secondly as a significant proportion of London's energy will continue to be sourced from the national grid, we will lobby government to ensure that the national grid is as low-carbon as possible. We will work with government to secure new funding and legislation in key areas. In particular we will be pushing for:

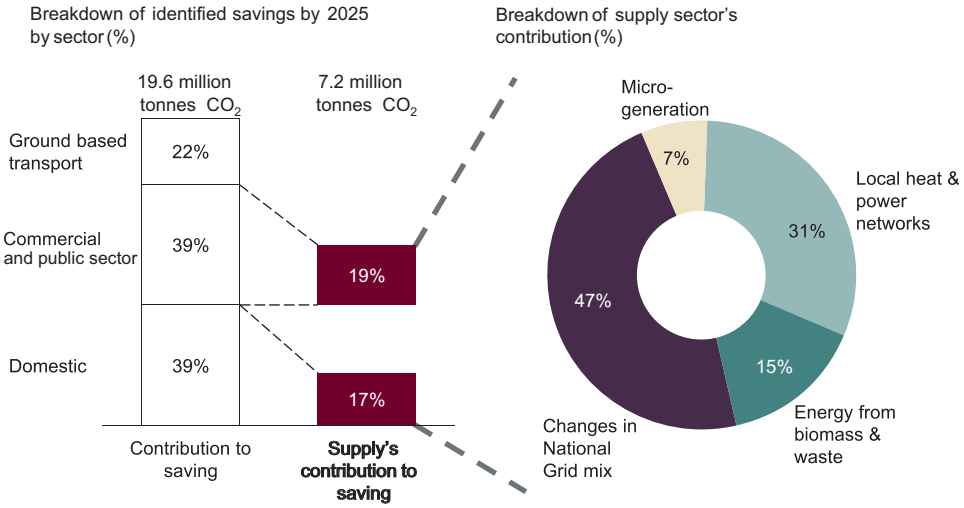
- simplification of the planning process for large-scale renewables, particularly on- and off-shore wind

- identification of funding mechanisms for demonstration-stage renewable technologies such as tidal and wave which together with wind provide an important low-carbon alternative to nuclear power
- simplification of the process to connect CCHP to the national grid, including fair payment for exported electricity and remove of exempt licensing regime restrictions on private wire networks to incentivise take-up of CCHP and renewable energy
- alteration to national planning regulations to mandate CCHP and micro-generation in new developments wherever possible
- the rapid uptake of carbon sequestration as a way to further reduce national grid emissions while the UK achieves a transition to a renewable energy based economy.

The Mayor will conduct a lobbying programme focused on delivering national legislation changes to facilitate the rollout of lower-carbon energy sources including larger uptake of large-scale renewables and making CCHP more attractive.

If successfully implemented, these Mayoral initiatives will facilitate the delivery of CO_2 savings of 7.2 million tonnes annually by 2025.

Figure 51 Supply sector's contribution to CO_2 savings by 2025



References

1 As evidence by "Powering London into the 21st Century" prepared by PB Power for Mayor of London and Greenpeace, March 2006.

2 This is available from http://www.london.gov.uk/gla/publications/environment.jsp#capsol

3 The applicability of offshore wind farms, onshore wind farms, biomass co-firing, anaerobic digestion of farm biogas, hydro power, tidal and wave energy, and landfill gas in London will be investigated.

4.5 Emissions from ground based transport

4.5.1 Overview

Transport is a significant source of CO_2 in London, although unlike in many other major cities, transport emissions in the capital are currently only about a fifth of overall emissions.

Although London's population and economy have been growing, transport emissions have stayed flat due to a combination of traffic management policies, aggressive investment in the public transport network and technological advancement. Since 2000, London has been the only major city in the world to achieve a shift from private car usage to public transport, cycling and walking. Transport emissions per capita in London are 45 per cent lower than the UK average. However, continued growth will put renewed pressure on the public transport network and could increase emissions substantially (20 per cent or more to 2025) if CO_2-reduction measures are not pursued across all modes.

Opportunities to reduce CO_2 emissions from transport are already being pursued in London on a greater scale than in most other cities, but efforts will have to increase dramatically if reduction targets are to be met. It will be critical to ensure that as many trips as possible are carried on lower-carbon modes: either public transport or walking and cycling. In addition to delivering projected CO_2 savings of up to 1.7 million tonnes each year, accommodating demand growth in this way addresses many other challenges facing London including air quality, noise and road congestion. There is also a wide range of new technologies, alternative fuels, and operational changes that can and should be urgently deployed to reduce emissions from public transport. For example, hybrid buses use 30-40 per cent less fuel than comparable diesel buses, and the rollout of new train features like regenerative braking on the Underground will realise energy savings of a similar size.

Whilst the Mayor is well-placed to deliver CO_2 emissions reductions from most parts of the public transport network, he has much less control over emissions from private vehicles, which constitute nearly half of London's transport emissions. For those trips where the car remains the best mode for the task, the Mayor will promote "eco-driving" approaches. These can reduce emissions and deliver fuel savings of up to 25 per cent - about £250-300 per year savings for an average car driver in London at current fuel prices. However, the greatest opportunity remains the accelerated adoption of low carbon technologies in both cars and freight vehicles. The Mayor will promote action in this area by working with government to establish supportive policies, encouraging vehicle manufacturers to act

responsibly and using pricing mechanisms, including road user charging, to encourage Londoners to make sustainable purchasing decisions.

The rest of this chapter covers

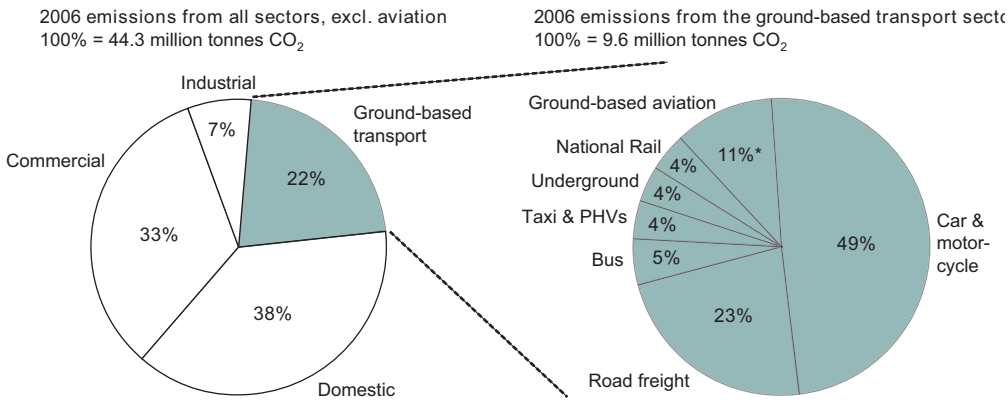
- Current and projected emissions from London's transport sector, including CO_2 reduction targets and an overview of key actions required to deliver the target
- Specific features of London's transport sector
- Summary of potential actions to make transport more energy efficient
- Actions already underway to tackle emissions from London's ground transport
- The Mayor's key priorities for action, with indicative CO_2 impact and cost.

4.5.2 Current and projected emissions from London's transport sector

Current emissions

London currently supports 27 million trips per day, resulting in emissions of 9.6 million tonnes of CO_2 per year, or 22 per cent of London's total emissions. Private road transport accounts for nearly three quarters of these emissions, with cars and motorcycles contributing just under half and road freight around one quarter[1].

Figure 52 2006 CO_2 emissions from the ground based transport sector



Note *Emissions from taxiing aircraft and during take-off and landing

Source London Energy and CO_2 Emissions Inventory, TfL

Future emissions

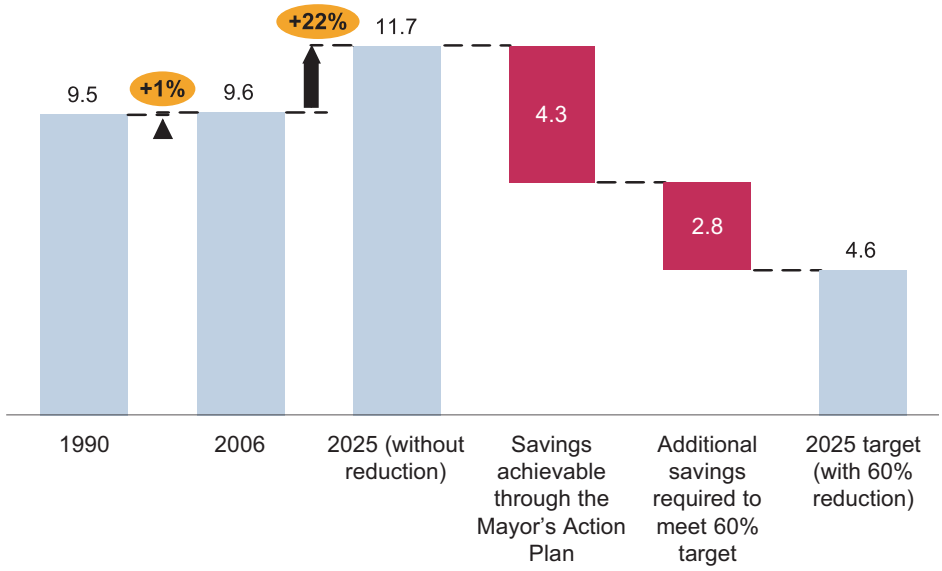
Given projected population and economic growth, demand for transport will increase over the period to 2025. Without intervention, car kilometres in London could increase by as much as eight per cent and freight traffic rise by 30 per cent from today's levels. Additional public transport capacity in the form of more buses and Underground trains will also be needed to meet demand. History would also suggest that realising substantial reductions in per kilometre CO_2 emission levels for new cars, trucks and buses, whilst possible, is by no means guaranteed. In all, this could lead to an increase in CO_2 emissions from ground transport of about two million tonnes to 11.7 million tonnes per annum in 2025, an increase of nearly 25 per cent.

Sectoral target

Taking the target of a 60 per cent reduction by 2025 from the 1990 baseline, ground transport would need to emit 7.1 million tonnes less CO_2 per annum by 2025.

Achieving this reduction will be extremely challenging, realistically requiring the establishment of a carbon pricing system and further EU and UK legislation. However, in the current environment a saving of 4.3 million tonnes is achievable by 2025.

Figure 53 **Ground based transport - comparison of 2025 CO_2 emissions with and without 60 per cent reduction**
Million tonnes of CO_2



How the target can be achieved

Reductions in transport emissions can come about through five main types of measures[2]:

- 10-20 per cent 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 per cent savings.
- 5-10 per cent 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 per cent emissions savings across the network.
- Use of lower-carbon fuels such as low-blend biodiesel is likely to be able to contribute a 10 per cent reduction in emissions[3].

4.5.3 Specific features of London's transport sector

London's current and future ground transport emissions are heavily influenced by mode share, each mode's emissions per passenger kilometre (taking into account the mix of vehicle types), and how each mode is operated.

Mode share

Ground-based transport is dominated by private road traffic; cars and freight together contribute 72 per cent of the sector's emissions:

Major ground transport modes	Number of Vehicles	Annual Vehicle km (bn)	Annual Passenger Journeys (m)
Cars	2.4m	25	3,869
Road freight	n/a	5.0	n/a
Buses	8,025	0.45	1,793
Taxis	21,700	0.89	88
Private hire vehicles	45,000	0.74	73
Underground	4,070 (carriages)	0.07	973
Rail	n/a	0.19	244
DLR	94	0.004	53
Croydon Tramlink	24	0.002	23
River services	39	n/a	2.4
Dial-a-Ride	360	n/a	1.2

Public transport contributes only 17 per cent of total emissions, split roughly equally between the four primary motorised modes (bus, Underground, rail and taxis).

Although road traffic has grown nationally at 1.3 per cent per annum over the past five years, vehicle kilometres in London have remained flat over the same period. Significant investment in the public transport network, including in non-motorised modes such as walking and cycling, coupled with the introduction of the congestion charging scheme (see boxed text), has proven to be very successful at ensuring that the growing demand for travel has been accommodated on modes other than car, especially in central London. In some areas of London, increases in traffic have in part been limited by road congestion. Overall, there has been a five per cent mode shift since 2000 from private vehicles to public transport, cycling and walking in London - a result not achieved in any other major city globally.

Congestion Charging in London

The groundbreaking central London Congestion Charge was introduced in February 2003. Vehicles entering the charging zone between the hours of 7am and 6.30pm on weekdays are now charged £8.

The charge was introduced with several objectives in mind:

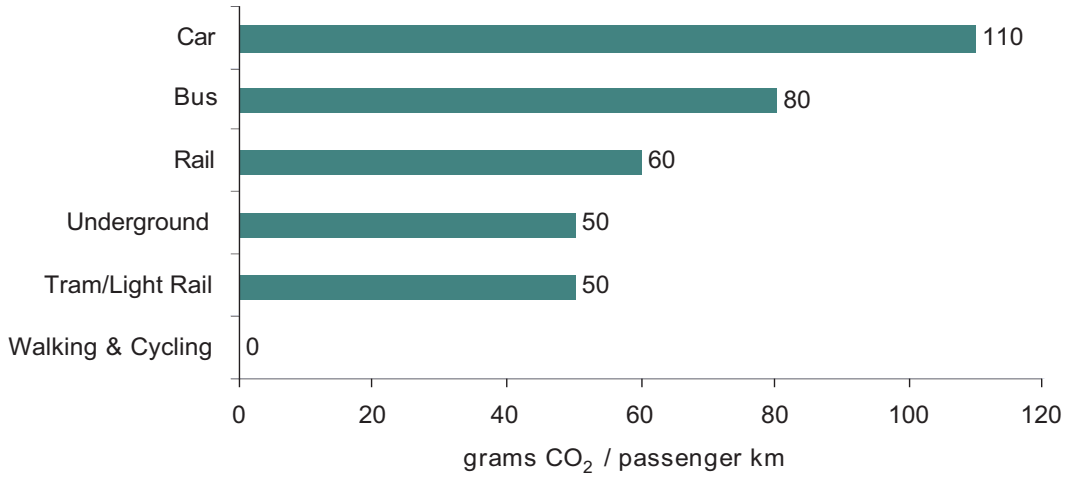
– to reduce congestion
– to enable radical improvements to bus services
– to improve journey time reliability for car users
– to make the distribution of goods and services more efficient.

The charge has proved to be very successful. Congestion within the zone has reduced by 22 per cent compared to pre-charging levels. Public transport continues to successfully accommodate displaced car users, and bus services continue to benefit from improved reliability and ongoing investment. Vehicle traffic inside the zone during charging hours is about 15 per cent below pre-charging levels, resulting in an estimated CO_2 emissions reduction of 16 per cent. This radical scheme, coupled with focussed investment in public transport, walking and cycling, demonstrates that integrated planning can achieve real improvements in transport network performance.

Emissions per passenger kilometre

Each mode's emissions are influenced both by the vehicle's energy consumption and by its occupancy. Cars emit the most CO_2 per passenger kilometre of all ground transport modes. The car emissions levels indicated would be 60 per cent higher with just one person in the car (London average is 1.6 people per car).

Figure 54 Average CO_2 emitted per passenger kilometre across various modes



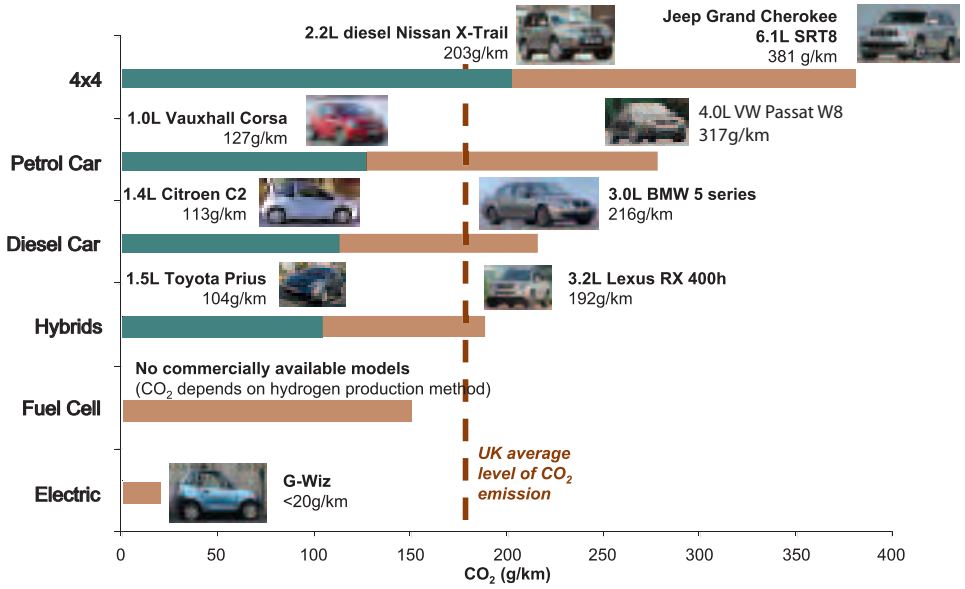
Notes Calculated using current load factors (15 people per bus in London and 1.6 passengers per car nationally)
Source TfL

Currently, the average car in London emits 178g of CO_2 per kilometre. However, the CO_2 performance of a car can vary considerably depending on aspects such as engine type, engine size and vehicle weight.

The importance of weight

Weight is a significant and often-underestimated factor in fuel efficiency: for example, a smaller traditional car may consume less fuel than a larger hybrid car. In fact, **if everyone buying a vehicle bought the most energy efficient vehicle in the class, emissions from private vehicles would be cut by roughly 30 per cent.**

Figure 55 CO_2 emissions from different car types



Operations and degree of influence

The Mayor's ability to shape and influence policy varies across different transport modes.

- The Mayor's transport body, Transport for London (TfL), operates the Underground and manages bus services and thus is able to influence the energy efficiency of these modes, partly through its own behaviour and partly through its contracts with operators.
- TfL also operates a number of smaller modes including the Docklands Light Railway, Croydon Tramlink, the Woolwich Ferry and Dial-a-Ride, although these sectors' contributions to transport emissions are relatively small.
- TfL regulates the black cab and private hire vehicle fleets.
- Overground rail services are operated by a variety of train operating companies, with supporting infrastructure managed by Network Rail. The Mayor has a very limited role in this area apart from being able to provide input into the high-level route strategies for the relevant rail franchises[4].
- The Mayor has some statutory policy powers over freight and private vehicles but does not directly control many aspects of the road network. TfL is responsible for traffic management of major roads (approximately five per cent of the road network), traffic lights and will soon oversee the management of roadworks. Voluntary collaboration with the freight industry is helping to mitigate the impact of freight traffic in London, but is limited by the fragmented nature of the industry.

4.5.4 Summary of potential actions to make transport more energy efficient

There are three broad measures that can be taken to reduce CO_2 emissions from transport:

a Changing the way we travel
b Operating our vehicles more efficiently
c Using improved vehicle and fuel types.

a Changing the way we travel

Encouraging greater use of public transport, walking and cycling is key to reducing CO_2 emissions from the transport sector. Policies aimed at promoting this shift are already being used successfully across London to tackle other important objectives such as improving local air quality. Actions that will have a significant bearing on the way we travel in the future include:

- continued investment in public transport to improve its attractiveness compared to private vehicles
- promotion of walking and cycling, including the creation of attractive urban environments conducive to these modes
- increased use of travel demand management (TDM) policies
- using fare structures and levels to promote public transport usage
- using pricing mechanisms to encourage more responsible private car usage
- reducing the need for travel through land use planning.

b Operating vehicles more efficiently

There are two opportunities capable of reducing CO_2 emissions:

- how drivers choose to operate their vehicles and
- engines' operating parameters.

Firstly, drivers can operate their vehicles in ways to minimise unnecessary fuel consumption. This requires no changes to the existing vehicle. Not only cars can benefit from eco-driving measures: buses, taxis, and freight vehicles can apply many of these measures as well and achieve anywhere from 5-10 per cent fuel savings as a result. Regular maintenance is also a simple way of improving fuel efficiency.

Secondly, vehicle engines can be designed and specified to operate as efficiently as possible. This can include intelligent coasting on the Underground, and so-called Intelligent Speed Adaptation (ISA) in freight

and bus engines. ISA systems automatically limit the speed of a vehicle, reducing fuel usage and providing road safety benefits.

c Using improved vehicle and fuel types

Finally, CO_2 emissions from transport can be reduced by changing type of vehicle or fuel used. Savings can be achieved by:

- Selecting lighter, more fuel efficient vehicles
- New types of engine technology
- Lower carbon energy sources.

Selecting lighter, more fuel efficient vehicles

New technologies and fuels offer the potential for much lower vehicle CO_2 emissions in the future. But you do not have to drive an electric or hybrid car, or fill up with biofuels, to achieve significant CO_2 emissions. And while driving a smaller car is also much better for the environment, simply choosing more fuel efficient cars from the range of vehicles already on the market can have a dramatic impact on your level of fuel consumption. This doesn't necessarily require compromise on car size or style, just consideration of fuel efficiency. For example a new 2.5 litre petrol Ford Focus on average emits 224gCO_2/km and would cost about £1,600 to run each year. In contrast, a new 1.6 litre diesel Ford Focus emits only 125gCO_2/km and has fuels cost of about £850 per year. This represents a CO_2 saving of 44 per cent and a fuel cost saving of 47 per cent.

Similarly, lighter rail and Underground cars require significantly less traction electricity. Weight related energy savings of 10-15 per cent have already been achieved through improvements to the design of steel constructed rolling stock. Carriages manufactured from aluminium alloys are up to 40 per cent lighter again and would deliver even greater savings.

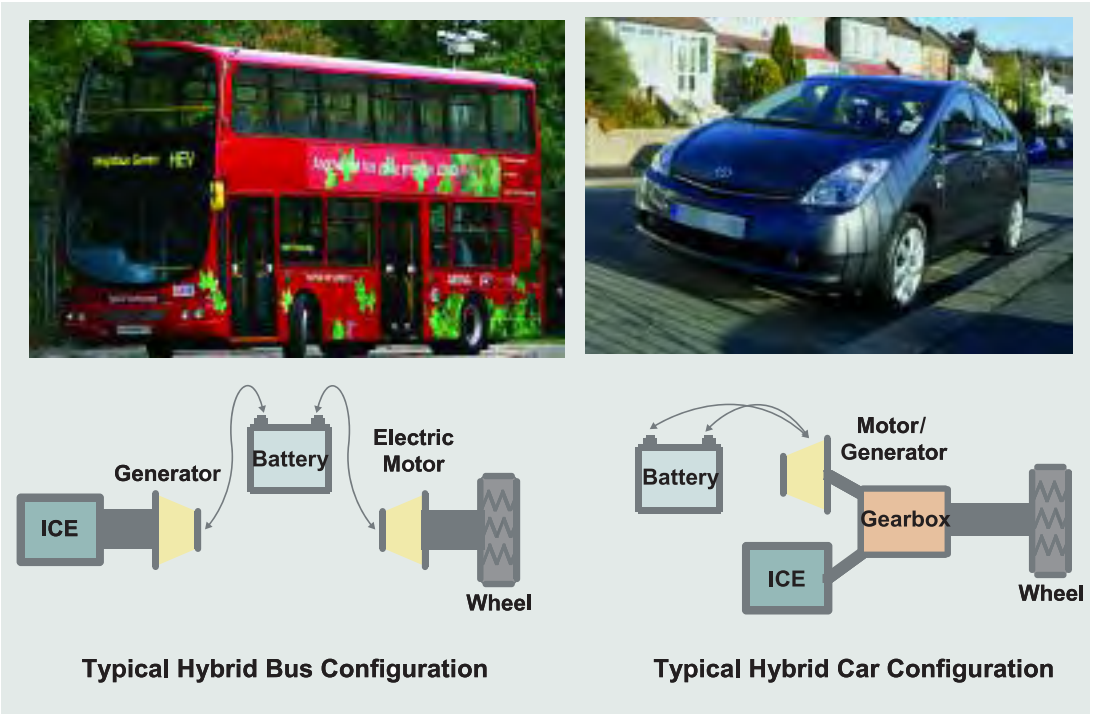
New types of engine technology

The past few years has seen the commercial launch of several new vehicle types that use new, more energy-saving propulsion systems compared to the internal combustion engine used in all vehicles up until very recently. Two current examples are:

- **Hybrid vehicles** use a combination of a standard internal combustion engine (ICE), a battery and an electric motor. Energy that would ordinarily be lost during braking is used to charge the battery, which in turn powers an electric motor that supplements a standard petrol or diesel engine. The battery in a standard hybrid car is not charged from the electricity grid. When operated in city environments, hybrids emit between 30-40 per cent less CO_2 than ordinary vehicles of a similar

size. A new variation on hybrid technology is the "stop and start" engine. In vehicles fitted with this system, the engine automatically stops just before the car comes to a standstill (eg, traffic lights). The engine then automatically restarts when the brake is released. For cars driven in the city this reduces fuel consumption and CO_2 emissions by about 10 per cent.

Figure 56 How a hybrid vehicle works



- **Electric vehicles** use a battery-powered electric motor. Electric motors are more than twice as efficient as internal combustion engines, greatly reducing the energy required and CO_2 emitted by up to 70-90 per cent per kilometre compared to today's average cars. The battery is charged directly from the electricity grid. Current technology is most suited to use in cars and short-route delivery vehicles. Most electric cars have an operating range of 50km, more than enough for the average daily commute and trip to the shops. CO_2 emissions per kilometre are much lower than for normal cars, in the range of 20-50g/km.

The next generation of energy-saving vehicles is already beginning to emerge. There is the potential for some of these vehicles to be zero carbon in the future if they use renewable electricity. Two examples are:

- **Plug-in hybrid electric vehicles** use the same basic propulsion system as current hybrid vehicles, but the battery is larger and can be

charged by the internal combustion engine (ICE) or directly from the electricity grid. As battery technology improves, these vehicles will move towards electric-only - possibly reaching a point in the future where the ICE is no longer required. Depending of the drive cycle, plug-in hybrids can use up to 50-80 per cent less fuel than a standard hybrid, resulting in CO_2 emissions of about 25-50g/km.

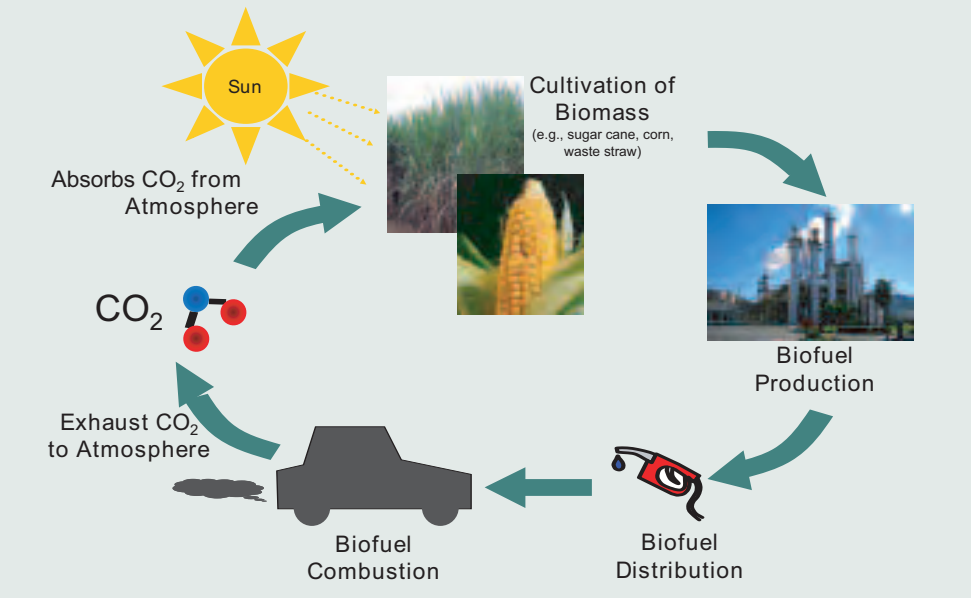
- **Hydrogen fuel cell vehicles** also use an electric motor. However, instead of storing the power they need to operate in a battery, a fuel cell is used to supply electricity to the motor. Inside the fuel cell, hydrogen is combined with oxygen to produce electricity in a chemical reaction. The only exhaust product from the car is water vapour. The overall CO_2 performance of the vehicle depends on the method of hydrogen production. Hydrogen produced from water using renewable electricity would result in truly zero carbon transport. But even using hydrogen made from natural gas, CO_2 savings of around 30 per cent are achieved. London has trialled three hydrogen fuel cell buses since 2004.

Lower carbon energy sources

Biofuels

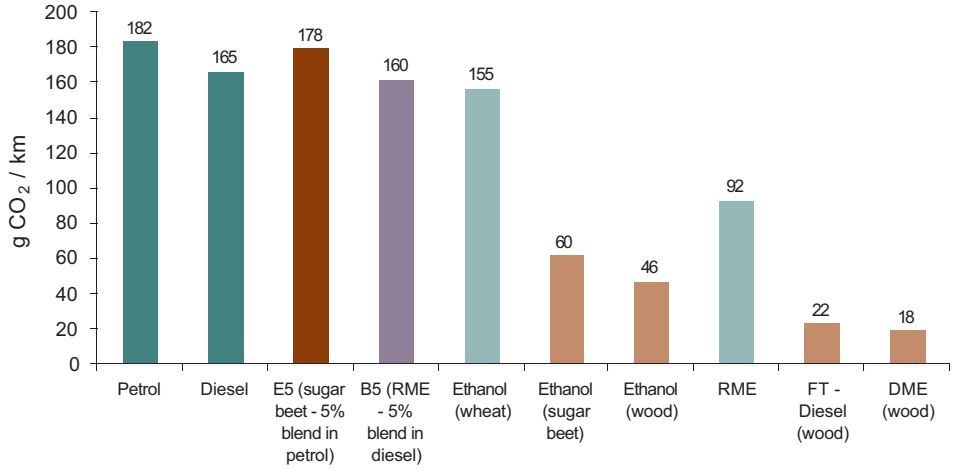
Vehicle emissions can also be reduced by the use of fuels with a lower CO_2 impact. Biofuels are fuels produced from crops (for example, corn, sugar cane) or from agricultural waste (for example, wheat stalks, straw). The net CO_2 emissions from the production and use of biofuels are generally lower than emissions from fossil fuels. This is because CO_2 is absorbed from the atmosphere during the crop growth phase. In contrast, combustion of fossil fuels releases carbon that has been trapped for millions of years below ground.

Figure 57 Biofuel production process



CO_2 reductions achievable from biofuels vary considerably and depend on the type of biomass used, the production method and the percentage in which they are blended with petrol or diesel fuels.

Figure 58 Well-to-wheel CO_2 emissions of various fuel types



Notes Emissions associated with petrol and gasoline production of have not been included. Well-to-tank emissions are estimated to represent about 16 and 11 per cent of the tank-to-wheels emissions for petrol and diesel respectively.
E5=5 per cent bioethanol, B5=5 per cent biodiesel, RME=Rape Methyl Ester, FT-Diesel=Fischer-Tropsch Diesel, DME=Dimethylether

Source Future Road Fuels, UKPIA, 2005

In the near term, typical CO_2 savings from biofuels are likely to be at the lower end of the range, i.e. around 20 per cent. "Second generation" biofuels are capable of delivering much greater savings because they use more efficient production process and greater quantities of waste biomass (i.e., towards 80 per cent), but these production processes have not yet been commercialised on a large scale.

Because the CO_2 saving associated with biofuel production can vary so widely, it will be very important to establish standards to guarantee the level of CO_2 saving associated with the use of a specific fuel. Key sources of variation include:

- Biomass feedstock
- Location of biomass growth
- Production process.

At the moment, there is no way of distinguishing between biofuels that could have very different CO_2 benefits in the marketplace. For example,

corn-based ethanol produced in the United States, which has little or no CO_2 benefit compared to fossil fuels (due to the quantity of energy used to grow corn and convert its kernels into ethanol), is sold on equal terms to Brazilian ethanol made from sugar cane, which is much easier to grow and process and achieves an 80-90 per cent reduction in CO_2 emissions. Standards must also provide assurance that the fuel has been produced sustainably. Otherwise shortsighted cultivation practices could lead to deforestation and loss of biodiversity.

Renewable Electricity

CO_2 emissions from operation of the Underground, Docklands Light Railway, Tramlink and electrified National Rail services will all benefit from the increased generation of electricity from renewable or low carbon sources. Specific opportunities to increase renewable electricity production are dealt with in Chapter 4.4. Increasing London's use of lower-carbon electricity sources will reduce these transport emissions.

4.5.5 Actions already underway to tackle emissions from London's ground transport

Transport for London investments to date

Following its inception in 2000, the Mayor's transport body Transport for London has secured groundbreaking funding agreements with the Government on grant levels and long-term borrowing. This has provided TfL with the opportunity to reverse decades of under-investment in the public transport network. This unprecedented investment will enable the development of a more sustainable network and will be key to achieving CO_2 reductions. Efforts to date include:

- Substantial investment in the public transport network, including a significant increase in bus capacity and the ongoing programme of Underground renewal. Already, approximately £4 billion has been spent since the start of TfL's investment Programme (including £2.3 billion on the Underground and £0.6 billion on buses).
- Increased investment in walking and cycling, for example TfL's cycling budget has increased from £5.5 million in 2000 to £24m in 2006/07. This additional investment has been used to deliver safer road layouts, an expanded London Cycle Network, more cycle parking and cycle training.
- Use of policies to encourage mode shift to more sustainable options. This has included fare incentives such as free travel for under-18s, protecting the Freedom pass for older and disabled Londoners, and the introduction of the congestion charging scheme, which has reduced traffic circulating within the central London zone by 15 per cent

compared to 2002 (pre-charging) levels and cut CO_2 emissions by 16 per cent.
- Increased use of incentives, marketing and information to make people aware of their travel options and promote the use of lower-carbon modes. This has included more than doubling TfL's travel demand management programme over the past three years, including significant progress in the areas of work, school and personal travel planning, support for car sharing and car clubs.

These measures have led to more walking trips and a 72 per cent increase in cycling on the major road network in 2005/06 compared to 2000. Bus ridership has increased by 40 per cent. In a recent MORI poll, the number of Londoners saying they use a car every day had declined by half, from 38 per cent of Londoners to 19 per cent. Since 2000, the net effect has been to avoid 500,000 car journeys each day that would have otherwise taken place - equating to an annual CO_2 saving of about 210,000 tonnes.

Transport sector beyond TfL

Beyond TfL, the main recent developments in energy saving in the transport sector have been:

- Voluntary agreements between the EU and car manufacturing associations
- Development of low-carbon engine technologies
- Proposed Renewable Transport Fuels Obligation
- Government policies to promote of low CO_2 behaviours.

Voluntary agreements

Voluntary agreements were secured by the European Union with international car manufacturing associations in the 1990s to reduce CO_2 emissions from new vehicles. New car emissions have fallen by just over 10 per cent since then - from an average of 190g/km in 1997 to 169g/km last year in the UK. However, the European target of 140g/km by 2008/09 will not be met in the UK and is unlikely to be achieved across the EU. Individual performance of car manufacturers within each of the associations has been mixed. Some have already achieved the 140g/km objective, while others have made little progress. The European Commission recently announced its intent to mandate a reduction in emissions to 120g/km by 2012. Details of this proposal will be consulted on in 2007.

Low-carbon engine technologies

Engine technologies with substantially improved fuel economy are becoming a part of standard vehicle ranges. Cars employing hybrid

engines, capable of operating using either petrol or biofuel, or employing innovative approaches such as automatically switching the engine off after prolonged periods of idling are now regularly seen on the roads of London.

Renewable Transport Fuel Obligation (RTFO)
The government is encouraging the development of the biofuel industry through the RTFO. This requires fuel suppliers to ensure that 5 per cent of their sales are from renewable sources by 2010. It is expected that legislation will be implemented during the first half of 2008.

Government policies
All levels of government are increasingly amending existing and creating new policies to promote low CO_2 behaviour. Recent increases to the vehicle excise duty (VED) on the most CO_2 polluting cars is a start, but by no means goes far enough to catalyse real change. At the local level, several London boroughs are taking positive action. Richmond is proposing differential resident permit charges on the basis of a car's CO_2 emissions and Westminster offers free parking to electric vehicles. A number of boroughs, including Waltham Forest and Islington, offer free resident permits for electric vehicles. Other boroughs in London have already implemented or have expressed interest in adopting similar measures.

4.5.6 The Mayor's key priorities for action

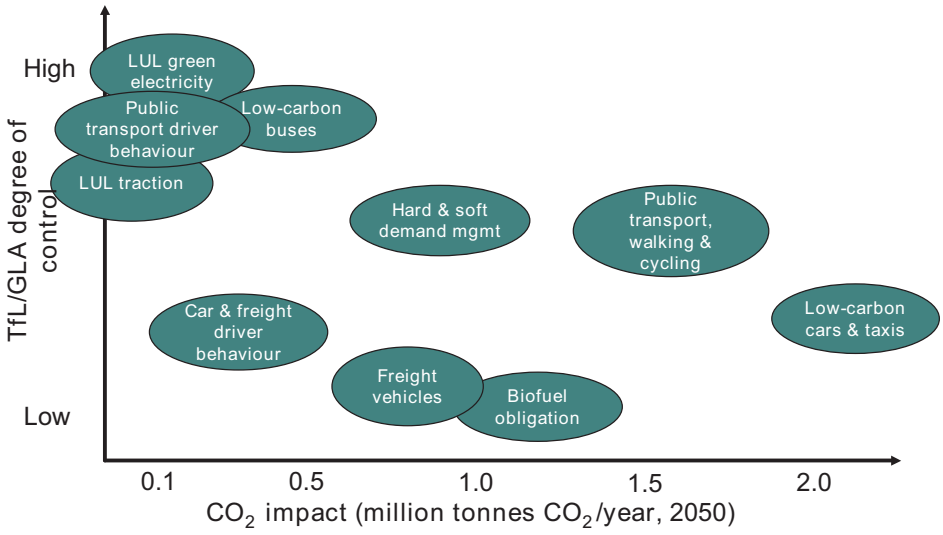
Much has already been done to keep transport CO_2 emissions down in London. In fact, it is the only sector where emissions are flat despite growing demand. But much more can - and must - be done. The Mayor will therefore take action across the three key areas mentioned above to:

a Change the way Londoners travel
b Operate vehicles more efficiently
c Promote the uptake of lower-carbon infrastructure, vehicle and fuel types.

Action across these three areas can deliver total savings of 4.3 million tonnes of CO_2, with changing the way we travel, operating our vehicles more efficiently and using improved vehicle and fuel types delivering 39 per cent, 17 per cent, and 44 per cent respectively.

The degree of influence that the Mayor has to achieve CO_2 savings varies considerably by opportunity. In some instances, savings can be delivered through Mayoral policy and functional body resources. However, in many of the most promising areas, Mayoral powers are far more limited. In these instances influencing individuals and the commercial and public sectors, as well as lobbying government and the EU, will be critical.

Figure 59 Degree of Mayoral control over key transport CO_2 opportunities



Details of Mayoral actions to reduce CO_2 emissions from the transport sector are set out below[5].

a Changing the way Londoners travel

Investments made in public transport, walking and cycling will continue to ensure that growth is accommodated on lower-carbon forms of transport. This has the potential to deliver annual CO_2 savings of 1.7 million tonnes by 2025. However, this will only be achieved by increasing the relative attractiveness of these more sustainable modes, by providing more pleasant, reliable and sometimes faster journeys, by making the most of travel demand management policies, by improving the quality of urban design and environment, and by taking steps to ensure that the cost of each transport mode reflects its true cost in terms of carbon emissions.

Public Transport

The Mayor intends to deliver key public transport projects, in large part through continued implementation of TfL's £13.1 billion investment programme. This is a programme of unprecedented scale and scope for London. Key Investment Programme and other infrastructure projects include:

- continued improvements to the Underground, including an increase in capacity of 28.5 per cent by 2025
- rejuvenation of London's overground rail network, including the Thameslink upgrade and longer, more frequent trains to southern areas of London and the Lea Valley. This will increase rail capacity by 25-30 per cent
- extension and upgrade of the existing East London Underground Line, converting it into a new heavy rail metro train service. The East London Line will be critical in bringing £10 billion worth of economic regeneration benefits to some of London's neediest areas, and will play a pivotal role in increasing capacity on key routes serving the 2012 Olympics
- Docklands Light Railway capacity enhancement (between Poplar and Stratford and an extension to Dagenham Dock)
- continued upgrade and expansion of London's bus network, resulting in a capacity increase of 40 per cent by 2025.

In addition the bill to build Crossrail is going through parliament. Crossrail would deliver an additional 10 per cent boost to the overall capacity of the public transport network and increase peak capacity by an additional 5.8 million passenger kilometres.

All of these projects will require continued funding support from government. The Mayor and TfL will continue to work closely with Government to ensure this funding is available.

Cycling

In addition to these significant public transport improvements, further enhancement of cycling infrastructure in London, together with creating a greater level of awareness of the benefits associated with this mode, will continue to be a focus for the Mayor.

London has targeted an increase in cycling trips of 400 per cent by 2025. To help make this a reality, TfL is committed to a range of measures designed to increase cycling levels, including:

- completing the 900km LCN+ cycle network by 2010
- installing secure cycle parking at schools and London Rail, Underground and DLR stations
- school travel plans for all schools, including making cycle training available to every primary school, including training for parents and carers.

Generating greater interest in cycling and its many benefits is also critical. Hosting Le Grand Départ of this year's Tour de France will bring cycling to the attention of many more Londoners. A Mass Participation Bike Ride in September 2007 will feed off the excitement generated by this world-famous event and momentum will be maintained by several other Tour de France legacy events. Existing cycling programmes will be repackaged and re-launched over this period to take full advantage of heightened levels of interest.

Walking

The Mayor also aims to make London one of the world's most walking-friendly cities over the next decade. An increase in walking of 10 per cent is targeted by 2015, with a longer-term aim of more than one million additional walking trips by 2025. Improvements to the city's streetscape and information to get Londoners using their feet will include:

- improvements to pavements, lighting and green spaces to create more attractive environments for pedestrians
- more permanent and temporary pedestrianised areas
- new and upgraded road crossings
- easy to read and consistently styled walking maps.

A key objective of planned public transport and walking and cycling improvements is to accommodate projected demand growth of four million additional trips a day to 2025 without an increase in car trips. This will avoid additional CO_2 emissions of up to 1.7 million tonnes per year.

Private vehicle transport

Travel Demand Management

The Mayor will continue to increase the use of travel demand management (TDM) policies. TDM refers to a range of tools designed to make most efficient use of available capacity, both on the roads and on public transport. These include:

- work, school and personalised travel plans - making people aware of the full range of travel options and helping them select the most appropriate one. This requires direct contact with Londoners and businesses to understand specific needs and options
- promotion of teleworking and video conferencing by highlighting cost and environmental benefits to business
- support of car sharing to increase passenger occupancy
- promotion and support of car clubs, for example by providing funding to boroughs to provide on-street car spaces
- promoting greater general awareness of public transport, walking and cycling through information campaigns.

Travel demand management is a relatively new policy and as such its effects continue to be tested and proven. To this end, TfL is currently conducting the first fully integrated pilot in collaboration with the borough of Sutton to determine the real impact of a holistic, properly funded TDM programme. £5 million has already been set aside to fund the full three years of the pilot. Measures being employed in Sutton are projected to reduce vehicle kilometres by up to five per cent. Preparation

for a second town centre pilot will commence in 2008/09, with roll out to other metropolitan town centres as soon as possible afterwards. In the interim, best practice from the Sutton pilot will be applied to other boroughs through the ongoing travel demand management programme. If the expected five per cent reduction in car kilometres can be delivered across London, this would reduce 2025 emissions by 0.25 million tonnes annually (about two per cent). The Mayor will also encourage boroughs to utilise the most CO_2 effective ways of calming traffic, for example using camera enforcement rather than speed humps.

Ensuring transport reflects the true cost of carbon

Encouraging a significant shift to more sustainable transport modes will remain challenging whilst the climate change impact associated with a particular mode is not fully incorporated into its cost. Ways the Mayor can ensure transport better reflects the cost of carbon include:

Extending and modifying the congestion charging scheme

Building on the success of the existing central London scheme, a western extension of the scheme, covering Kensington, Chelsea and Westminster, came into effect on 19 February 2007. As well as bringing traffic reduction to these areas, CO_2 savings on a similar relative scale to those realised by the current scheme are expected.

In an attempt to incentivise the purchase of lower CO_2 emitting cars, the Mayor has proposed the incorporation of emissions-influenced charging into the congestion charging scheme. Under the proposal, individuals would be encouraged to buy the most fuel efficient cars through a 100 per cent discount (cars emitting <120g CO_2 per km and meeting Euro IV air quality standards) and dissuaded from purchasing the most polluting vehicles by a higher than standard charge (£25 for cars emitting >225g CO_2 per km). On the current profile of vehicles entering the central London congestion charge zone, around 16,000 vehicles per day would be required to pay the £25 charge. This proposal will undergo a public consultation over the next year.

Supporting complementary national and local government policies

The Mayor will lobby the national government to make more radical changes to the charges on vehicles falling into different Vehicle Excise Duty (VED) bands. The tax levied on the most polluting categories must be increased further if car purchasers are to be influenced to select lower-carbon cars. Similarly, those driving cars in bands A and B must be rewarded. At £210 per year, the current maximum differential in VED is not substantial enough to change many people's purchasing decision. But the potential CO_2 saving is worth the change; even conservative

assumptions indicate that low-carbon vehicles would reduce CO_2 emissions by at least 0.8m tonnes annually by 2025.

The Mayor will also support borough-based "carbon-pricing" initiatives, such as Richmond upon Thames's plan to revise permit-parking charges on the basis of CO_2 emissions.

More widespread carbon pricing is clearly going to be necessary to achieve behavioural change in a number of areas, including the use of road vehicles and the uptake of low-carbon vehicles. Ideally, this would be implemented on a national or even European level. The government has indicated that it wishes to trial national road pricing, perhaps charging vehicles on the basis of mileage. The Mayor has stated that he would support the government in this.

London-wide road pricing is likely to be necessary before 2025 if London is to achieve its carbon emissions targets. However, it is difficult to predict precisely when this measure will become cost effective compared with other carbon reduction measures. At present it would have high costs relative to the carbon reduction benefits, although there would be wider economic benefits in the form of time savings from decongestion. This action plan prioritises other, more affordable, methods of reducing carbon emissions from transport over the next decade.

b Operating vehicles more efficiently

As discussed in previous sections, small and painless changes to driving practices can substantially reduce fuel or electricity consumption (and CO_2 emissions) across all modes.

Cars

Starting later this year, TfL will work with the DfT and other stakeholders to promote fuel-efficient motoring in London. The campaign will link in to national eco-driving campaigns and target both individuals and businesses.

For car drivers, eco-driving measures would include:

- accelerating and decelerating smoothly (5-10 per cent saving)
- keeping tyres inflated to the right level (2-4 per cent saving)
- removing roof racks when not in use (up to a 10 per cent saving)
- turning off engine when idling (allowing the car to idle for longer than 10 seconds uses more fuel than restarting)
- taking the car for regular inspection and servicing (about 4 per cent saving)
- not speeding: driving at 85 mph uses 25 per cent more fuel than driving at 70 mph.

Underground

The Underground will promote behavioural change amongst its staff and contractors to deliver energy savings. Smoother driving of trains in particular can deliver savings of ~5 per cent of the Underground's emissions.

Buses

Bus drivers will also be encouraged to drive their vehicles in ways that are more efficient. The existing BTEC training programme (which all London bus drivers go through) already highlights good practices but with greater emphasis it will be possible to reduce fuel consumption by 5-10 per cent. Bus priority measures, such as bus lanes, are another way of ensuring smoother bus travel and lower fuel consumption. Lower fuel costs mean cheaper fares for Londoners - not to mention a more comfortable and safer ride.

Taxis and private hire vehicles

The Mayor and the Public Carriage Office will work with the taxi and private hire industry to help reduce fuel costs. Fuel consumption can be reduced by more than 10 per cent through eco-driving practices. This will save the average black cab more than £400 per year in fuel costs - savings that will result in Londoner's paying lower taxi fares in the future.

Freight

Road freight is expected to experience dramatic growth - up to 30 per cent increase in vehicle kilometres by 2025. Collaboration with industry will be essential for two schemes targeting behavioural change that can cut fuel consumption:

- A new "Freight Training Initiative". Training will focus on drivers, but will also cover freight load planners and managers. Benchmarks will be used to help individual operators target parts of their operations where greatest fuel savings are possible

- Freight Operator Recognition Scheme (FORS) to reward operators for achieving fuel efficiency, environmental performance and safety objectives.

TfL will work with the freight industry to further develop shared consolidation centres to make freight movements more efficient, and will continue to encourage the use of rail and water for freight. Delivering CO_2 efficiencies is very much in the economic interests of freight operators: fuel typically represents 20-30 per cent of operating costs. Simple changes to delivery planning, vehicle maintenance and driving behaviour can deliver fuel efficiency improvements in excess of 10 per cent. Over the medium term, more substantial changes such as shifting to lower-carbon vehicles will deliver further, even more substantial fuel savings for freight operators. The benefits of this shift will also flow on to all Londoners in the form of improved air quality, quieter lorries and lower prices for food and other goods[6].

c Promote the uptake of lower-carbon infrastructure, vehicle and fuel types

The third key area of action is reducing CO_2 emissions across all public and private modes through the uptake of lower-carbon infrastructure, vehicles and fuels. Within TfL, rapid adoption of low CO_2 vehicles, infrastructure and fuels is being pursued through a range of investment decisions and policies. In addition to existing funding streams, many of these initiatives will be supported by the new £25 million TfL Climate Change Mitigation Fund.

Underground

The Underground is London's largest single user of electricity, accounting for 3.5 per cent of total electricity usage in the capital. Although it represents only four per cent of transport sector emissions, the underground is essentially under Mayoral control, making it possible to deliver real and sustained energy savings through energy-efficiency measures and the "greening" of energy supply.

Achieving these reductions will also benefit the Underground (and hence Londoners) financially. In 2006, the Underground's bill for traction electricity was £55 million, up 80 per cent from the previous year. Putting in the CO_2 savings initiatives described below would reduce this bill by as much as £15-10 million each year[7]. So how will these reductions be delivered?

- **Energy-efficient operations.** The Underground will seek to consistently define its operational specifications to prioritise energy-

efficiency. This could deliver emissions and energy savings of 10-30 per cent. This does not require significant infrastructure replacement. Rather, it involves introducing energy usage minimisation as a key parameter in all operating specifications, and in some cases introducing specific energy-savings measures. These measures - such as intelligent coasting, which reduce traction energy consumption by 20 per cent - are often justified from a railway engineering standpoint anyway, in this case because they reduce wear and tear on trains and track.

- **New infrastructure.** Energy-efficient equipment will be specified as standard during regular upgrade and repair cycles wherever possible and feasible. For example, specifying low-loss conductor rail can deliver 10 per cent savings in energy and emissions. Specifying trains that use regenerative braking, where the train's braking power is fed back into the traction network, can deliver energy savings of 25 per cent. Inverting substations that maximise the benefits of regenerative braking would increase this by a further 10-20 per cent. London Underground will work with the London Climate Change Agency and others to develop combined cooling, heat and power opportunities, including projects associated with cooling the tube. Changes to the power supply voltage are also being investigated, which have the potential to reduce energy losses due to resistance in the electricity supply network.
- **Renewables.** Simply increasing the amount of electricity procured through green tariff contracts may not necessarily result in a reduction in UK CO_2 emissions[8]. With electricity generators already obliged to supply a proportion of their electricity from renewable sources, paying for green tariff electricity may not be the best way to promote additional renewable supply in the long term. The Underground will look to make use of its market power by ensuring that it catalyses new investment in renewable or good quality CCHP infrastructure. Micro-renewables should be explored for station applications, but are not capable of contributing significantly to traction demand.

Buses

Buses are responsible for the emission of 680,000 tonnes of CO_2 annually, making them the largest transport sector emitter over which the Mayor has direct control. London represents one-third of the market for new buses in England due to the Mayor's commitment to continued improvement to the bus fleet and network. As such, London can exert significant influence on the UK bus market as a whole. As demonstrated over the past few years with the introduction of low-floor buses, it is possible to deliver rapid changes in fleet composition when there is a clear mandate to do so. A further benefit is that retired London buses are often sold on to other regions, so improvements to the fleet will have knock-on benefits to the UK's carbon footprint.

- **Hybrid buses:** the Mayor has announced that all new buses will be diesel-electric hybrids as soon as there is volume production available, which appears likely in the next few years. These buses emit between 30-40 per cent less CO_2 than comparably sized diesel buses. This sends a clear signal to manufacturers designed to result in increased production and decreased costs of hybrids. Whilst the initial purchase cost of a hybrid bus will remain higher than diesels for the immediate future, much of this premium is recouped over the operating life of the bus due to lower fuel consumption. In fact, fuel price increases of as little as 15 per cent would make hybrids a more attractive technology than standard diesels solely on financial grounds. TfL already operates six single-deck diesel-electric hybrid buses on route 360, and will trial the world's first double-deck hybrid bus on route 149.

- **Hydrogen fuel cell buses:** in parallel, TfL will also continue its support of hydrogen-powered buses on specific routes to accelerate development and eventual commercialisation of this technology. It will introduce 10 hydrogen fuelled buses as part of the London Hydrogen Partnership Transport Action Plan by 2010.

Hydrogen - potential CO_2-free transport in the future

Many people consider that hydrogen fuel cells will be able to provide CO_2-free energy in the future. The London Hydrogen Partnership, which was launched in April 2002, is working to make this technology a reality.

Producing energy using hydrogen fuel cells has many benefits including:

- reduced CO_2 emissions and noise
- improved air quality
- greater energy security.

The partnership comprises both public and private sector partners and is chaired by the Deputy Mayor. Its members include Air Products, Baxi-SenerTec UK, BP, BMW, BOC, Carbon Trust, DTI, Energy Saving Trust, Fuel Cell Europe, Greater London Authority, Health and Safety Executive, Imperial College, Intelligent Energy, Johnson Matthey, London Development Agency, London First, Rolls-Royce, Thames Water and Transport for London. It aims to develop London's hydrogen economy by:

- producing and implementing a London Hydrogen Action Plan
- establishing and maintaining dialogue among all sectors/actors relevant to the hydrogen economy
- disseminating relevant materials
- providing a platform for funding bids and initiation of projects - creating conditions where these technologies can thrive.

Further details on the activities of the partnership can be found at www.lhp.org.uk

National Rail

With the exception of the North London Railway where TfL takes responsibility for overseeing operations from November 2007, the Mayor does not have direct control over rail CO_2 emissions. However TfL works closely with the Department for Transport and Network Rail and is collaborating with Rail Safety and Standards Board in efforts to reduce traction energy use.

In general, many of the CO_2 reduction opportunities associated with the Underground are also applicable to the National Rail network.

- **Regenerative braking:** Britain has Europe's youngest fleet of rolling stock, almost all of which is already equipped with regenerative braking functionality. TfL will encourage the Department for Transport

and Network Rail to make the necessary upgrades to power supply infrastructure to make sure it can use the energy produced by regenerative braking on the trains.

- **Renewables:** TfL will also encourage Train Operating Companies to source the energy used on electrified sections of track increasingly from renewable sources. TfL is also keen to explore opportunities to use biofuels on the diesel-powered North London Railway, which runs between Gospel Oak and Barking, once TfL controls the concession after November 2007. TfL has also offered use of this line to the DfT for any trials that could reduce CO_2 emissions from local or suburban diesel trains
- **Electrification:** In the longer term, TfL is committed to pursuing the electrification of the North London Line, which would yield a 25-30 per cent CO_2 saving compared to diesel

Taxis

- **New engine technologies:** TfL has already had productive conversations with London Taxis International (LTI) the main supplier of taxis in London, regarding potential opportunities to develop a London taxi that employs engine technology capable of achieving significant improvements in fuel economy. New low-carbon technologies will also help to realise increasingly stringent air quality standards, such as Euro V. TfL's licensing powers and control over fare structures provide practical ways of encouraging uptake of these vehicles

Cars and Freight Vehicles

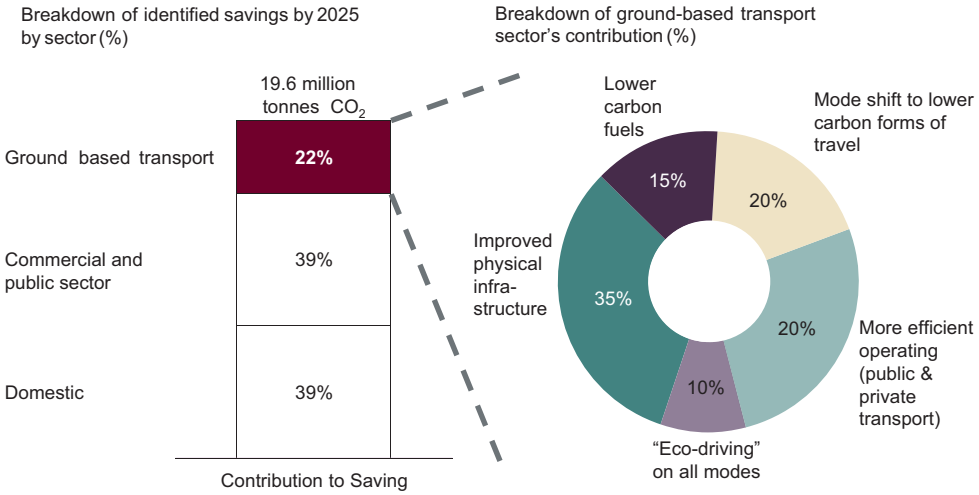
There are very few direct opportunities for the Mayor to directly promote the development and adoption of low carbon technologies and fuels.

Proposed changes to the congestion charging scheme (discussed above) will encourage Londoners to purchase greener cars and implementation of the London Low Emission Zone will over time promote the adoption of newer, cleaner freight vehicles. Beyond these measures, the Mayor will use all indirect channels available to him to promote these technologies and fuels including the following:

- **Passenger car CO_2 targets:** the Mayor will lobby the UK government and EU to establish mandatory reduction targets for car manufacturers to replace existing voluntary agreements that expire in 2008. Association based targets have proven to be ineffective. Manufacturers must be held directly accountable for the delivery of much lower CO_2 emitting cars in the future. A combination of mandatory targets, carbon pricing and carbon trading will be required to catalyse the rapid uptake of low emission vehicles.
- **Greater public awareness:** there is generally poor awareness regarding the wide-ranging CO_2 performance of makes and models across and within vehicle classes. Added to this, fuel efficiency and CO_2 emissions particularly, do not feature prominently amongst the criteria considered when buying a new car. The Mayor and TfL will develop campaigns to make motorists more aware of the climate change impact of their car purchases. It has been estimated that the total amount of CO_2 emitted from private vehicles in the UK could be reduced by as much as 30 per cent if buyers simply chose the most fuel efficient model in their desired vehicle category.
- **Biofuels:** the Mayor will lobby for the establishment of an EU accreditation system for biofuels to ensure sustainable production and guarantee minimum levels of CO_2 reduction. TfL will work with the Low Carbon Vehicle Partnership to help where it can in establishing a robust accreditation system for biofuels to be introduced in conjunction with the UK Renewable Transport Fuel Obligation. The Mayoral group will work with its fuel suppliers to ensure the biofuel it uses (in both low and high blend fuels) are from high quality, approved sources.

Successfully implemented, these mayoral initiatives will facilitate the delivery of CO_2 savings of 4.3 million tonnes annually by 2025.

Figure 60 Ground based transport sector's contribution to CO_2 savings by 2025



References

1 Smaller public transport modes including the DLR, Croydon Tramlink, river services and Dial-a-Ride contribute less than one per cent of total transport CO_2 emissions. Emissions from minor modes are estimated as follows: DLR - 19,350 tonnes, Croydon Tramlink - 5,515 tonnes, Woolwich Ferry (the only river service controlled by TfL) - 2,426 tonnes and Dial-a-Ride - 2,399 tonnes.

2 Percentage savings are not additive. They refer to the potential saving associated with a single initiative type.

3 Clearly low/zero-carbon fuels could deliver massively greater emissions reductions if
a) the rate of technological advance were accelerated, and
b) national and international pricing mechanisms and regulations were in place to incentivise or require faster take-up of these technologies.

4 This is set to change somewhat in 2007, when TfL will take over responsibility for the North London Line.

5 Achieving emissions reductions from ground-based aviation movements will be addressed in the aviation chapter. Smaller modes that represent <1 per cent of transport emissions are not addressed in this document, although emissions reduction programmes are being pursued.

6 The proposed London Low Emissions Zone will also by critical to improving London's air quality.

7 Based on current electricity consumption. Increases in absolute levels of consumption due to imminent line upgrades will increase overall energy costs and the size of potential savings.

8 A green tariff contract requires the energy supplier to obtain an amount of electricity equal to the customer's usage from existing renewable energy sources.

4.6 Emissions from aviation

4.6.1 Overview

Emissions from international aviation are not part of CO_2 reductions obligated under the Kyoto Protocol and are not routinely included in the UK government's assessment of emissions.

With aviation currently accounting for only 2-3 per cent of global CO_2 emissions, this may seem quite reasonable. However London's role as an international aviation hub means that aviation emissions account for 34 per cent of its total carbon footprint. Furthermore, continued dramatic aviation growth is also predicted, which implies that as the century progresses the contribution of aviation to climate change is likely to become very significant.

Aviation is one of the most environmentally damaging modes of transport. Per passenger kilometre, air travel is the most CO_2-intensive form of travel and of course trips by air tend to cover the largest distances. This impact on the climate is exacerbated by the release of CO_2 and other greenhouse gases high in the atmosphere, where the negative effect of these emissions is more than doubled.

Air travel is also one of the key elements of today's global economy, so aviation emissions present a global challenge. London is a major UK and international air travel hub, with London's airports handling 30 per cent of passengers entering or departing the UK[1]. London's role in the world economy and its "world city" status depend on these links with the rest of the world.

In principle aviation fits within the same simple framework applying to all carbon emissions. In practice, however, the industry poses certain specific issues.

The fundamental principle is that overall carbon emissions must be capped at a level preventing climate change. From this point of view what is important is the overall quantity of emissions not their source. However, it may be the case that within an acceptable overall carbon cap, society may in the future decide to take more stringent measures to prevent heat escaping from buildings, which produces no benefit, in order to permit more travel - which does have benefits.

At present, however, two interrelated problems exist, first that the real price of carbon emissions is not built into the price of air travel - meaning each air trip in fact does damage that does not have to be paid for. This can only be dealt with by including aviation within a comprehensive system of carbon pricing. Secondly, while this is introduced, because the cost of air travel is in real terms under-priced, the build up of air travel is so rapid that it threatens to overwhelm the benefits derived from limitations of emissions in other areas. This means that until a comprehensive system of carbon pricing is introduced physical controls and/or financial disincentives will have to be used to prevent unacceptable damage being done by the build up of emissions from aviation.

Aviation emissions today account for approximately seven per cent of total UK CO_2 emissions. However, forecasts suggest that historic growth rates of 6-7 per cent per annum are likely to continue and possibly increase if the market and regulatory environment remains as it is. Government projections therefore predict a 50-200 per cent increase in CO_2 emissions from aviation by 2050, by which time it would account for most of the UK's overall CO_2 budget, assuming reduction targets were met in other sectors.

Ideally, improvements to engine efficiency and aircraft design would bring per-passenger emissions down dramatically, thereby allowing continued growth in demand. However historical improvements of 1-1.5 per cent per annum in engine efficiency will not be remotely adequate to counterbalance expected growth. Looking to the future, there are no significant, available or emerging alternatives to existing airframe/engine design or fuel source. Lead times for research and development are particularly long in the aviation industry (often several decades) given technological complexity and safety concerns. Furthermore, the 30-year lifetime of aircraft means that without unprecedented regulatory intervention it will be slow to churn into the fleet.

For aviation, unlike most other sectors considered in this plan, there are real technological, as well as political and regulatory barriers, to reducing its carbon emissions. Since dramatic changes in plane technology are unlikely to be available in the short to medium term, we need to look at reducing our demand for air travel.

Since 1990, leisure flights have accounted for 86 per cent of the growth in passengers, and today nearly 80 per cent of flights from London-area airports are for leisure purposes. Leisure air travel is forecast to continue to be the main driver of future growth. Perhaps more importantly, a small percentage of the UK population is taking a significant number of flights a

year with half of all trips accounted for by only 11 per cent of the population.

It is clear that - given projected growth in this sector - emissions from aviation cannot be ignored. Yet unilateral action by the UK could harm UK and London's competitiveness and might not be effective, with traffic simply shifting to other European hubs. On the other hand, the UK should not take decisions now that will lock-in or encourage future aviation growth. In the absence of major technological advances that reduce emissions from aircraft, the Mayor will:

- work with the aviation industry to implement efficiencies that can deliver a step-change reduction in emissions
- seek to influence aviation policy at an European Union and international level
- challenge the need for further runway expansion at UK airports
- advocate demand management mechanisms to limit unsustainable, rampant growth in low-value flights
- advocate alternatives to air travel, including developing affordable, high-speed national rail services which can offer comparable journeys at one-third to one-half the CO_2 impact per passenger.

The rest of this chapter covers

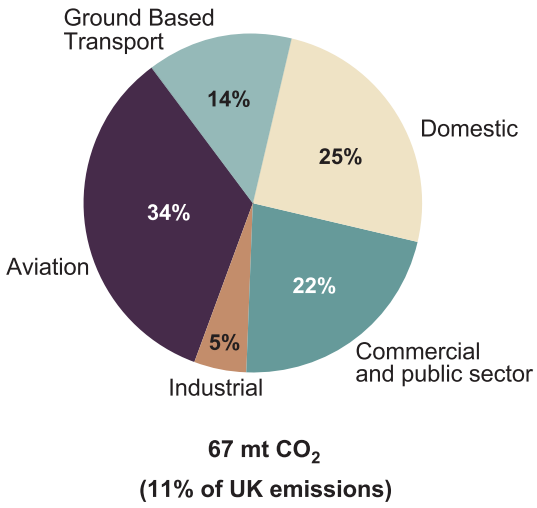
- Current and projected aviation emissions from London area airports
- Specific features of London's air travel market
- Summary of potential actions to reduce emissions from air travel
- Actions already underway to tackle emissions from aviation
- The Mayor's key priorities for action

4.6.2 Current and projected aviation emissions from London area airports

Current emissions

The UK's share of emissions from flights originating or arriving at London airports comprises about 20m tonnes of CO_2 per year[2]. If this were formally counted in London's emissions, it would triple London's transport emissions and add nearly 50 per cent to London's total emissions.

Figure 61 2006 carbon dioxide emissions from London including aviation



Note 2006 figures based on latest available LECI data (for 2003), projected to 2006 based on projections for each sector

Source London Energy and CO_2 Emissions Inventory; Defra

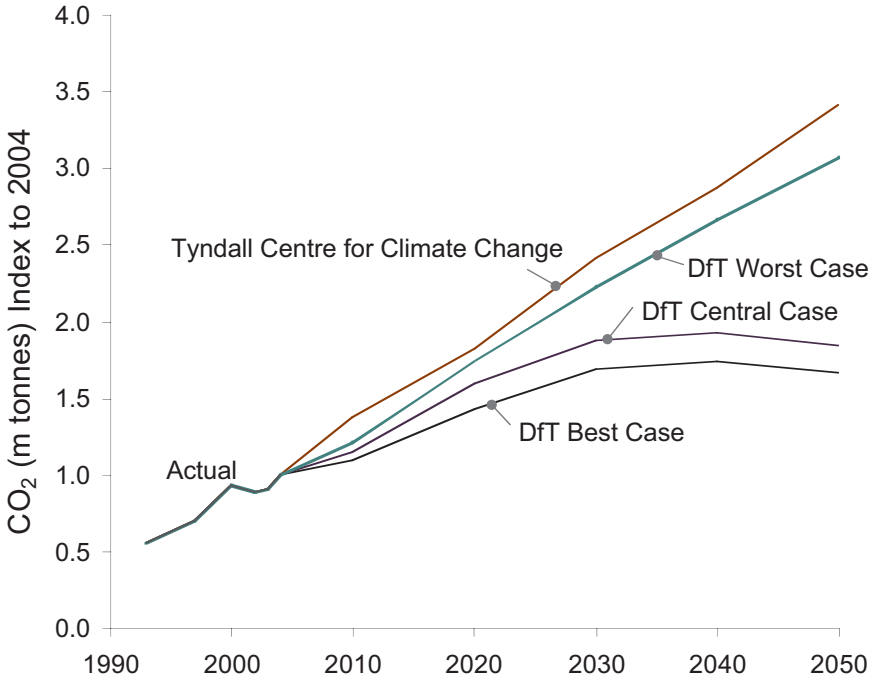
Aircraft emissions are particularly damaging for the climate because they are emitted high in the atmosphere – as a result their impact is doubled. This is not so much due to CO_2 emissions, but rather other greenhouse gases, water vapour and other emissions, which combine to more than double the effect from CO_2 alone.[3]

Future emissions

Rapid expansion of air travel is expected over the next 20 years and beyond. The UK Department for Transport's "central case" aviation growth assumptions suggest that UK CO_2 emissions will rise to 35m tonnes by 2025, an increase of over 50 per cent from today. The high case suggests an increase of over 100 per cent in 2025. Independent estimates, for example from the Tyndall Centre for Climate Change, project even greater increases. These may sound dramatic, however the Tyndall case assumes only four per cent per annum growth from 2010-2030 (compared to

current rates of 6–7 per cent per annum) and assumes continued engine efficiency improvements along the lines of those in the past. Dramatic growth is therefore not difficult to believe.

Figure 62 Projections for aviation emissions growth in the UK by 2050

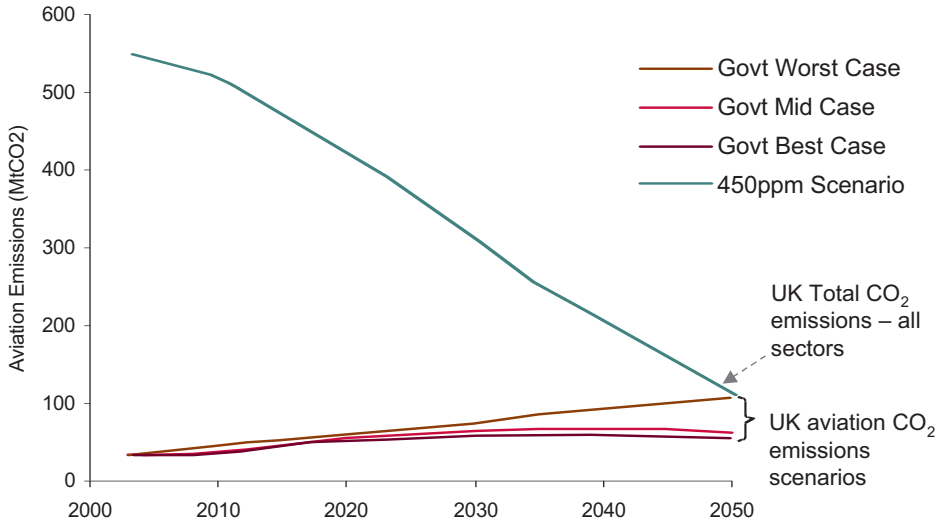


Note Assumes a 50:50 split for fuel use on international flights between the country of departure and arrival

Source "No chance for the climate without tackling aviation" Tyndall Centre for Climate Change, 2005

These projections are concerning when we consider the need to deliver carbon reductions. Measured against targets to reduce CO_2 emissions by 90 per cent by 2050 from 2000 levels, unconstrained growth in aviation would mean that aviation emissions will exceed the UK's total carbon allowance by the middle of the century. These emissions projections already assume continued engine efficiency improvements of 1-1.5 per cent per annum to 2050.

Figure 63 Overall UK emissions targets compared to government aviation forecasts



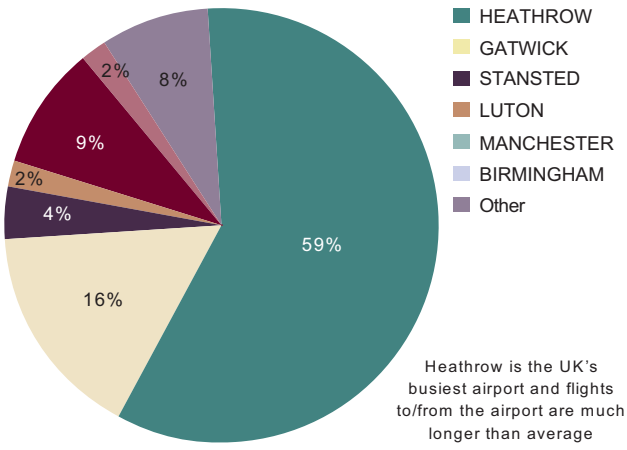
Source Tyndall Centre for Climate Change, Royal Commission

4.6.3 Specific features of the UK and London's air travel market

London's role

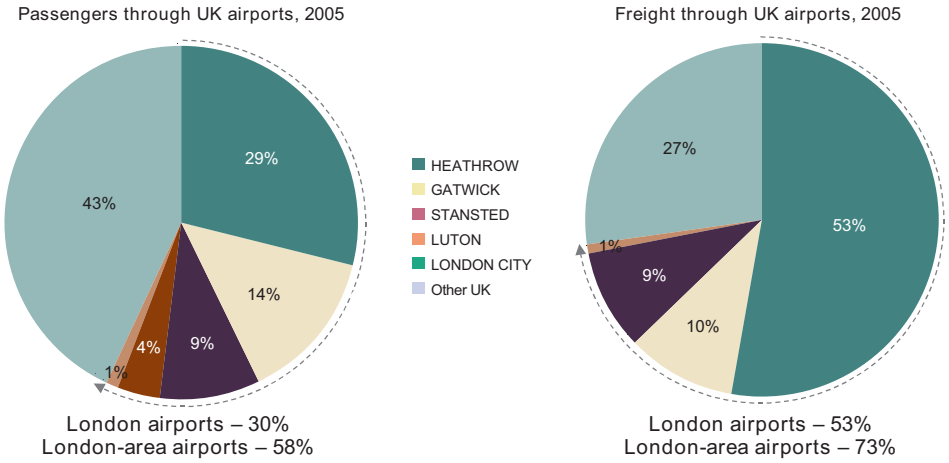
London is a major hub for flights to and from the UK and Europe. Flights to and from Heathrow alone comprise nearly 60 per cent of total UK passenger kilometres. London also accounts for 53 per cent of UK air freight.

Figure 64 Passenger kilometres to and from UK airports



Source CAA

Figure 65 Role of London in UK air passengers and air freight

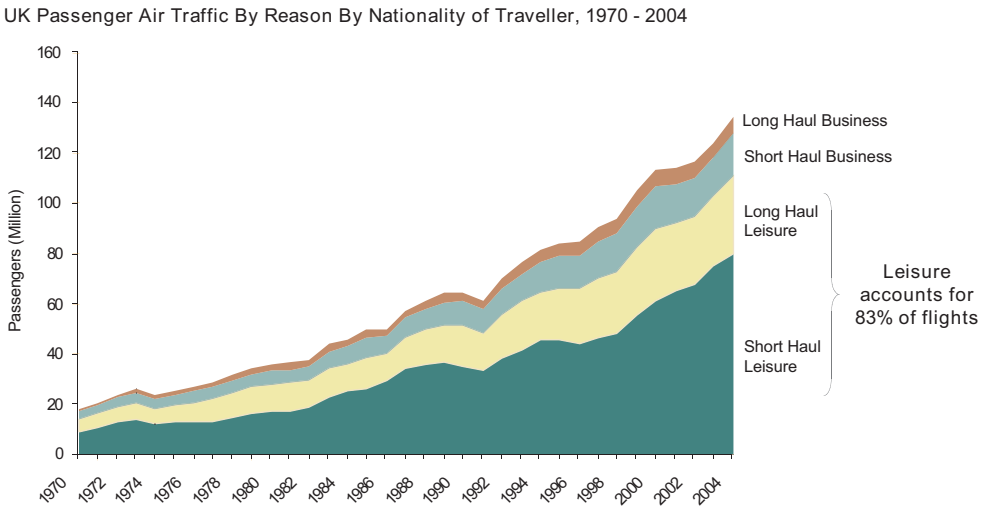


Source CAA

Composition of flights

Since the early 1980s, passenger trips have risen at an average rate of six per cent per annum (with freight air transport growing at seven per cent). The key driver of aviation growth has been leisure travel. It has accounted for over 80 per cent of all growth since 1990 and now accounts for over 80 per cent of all flights into and out of the UK.

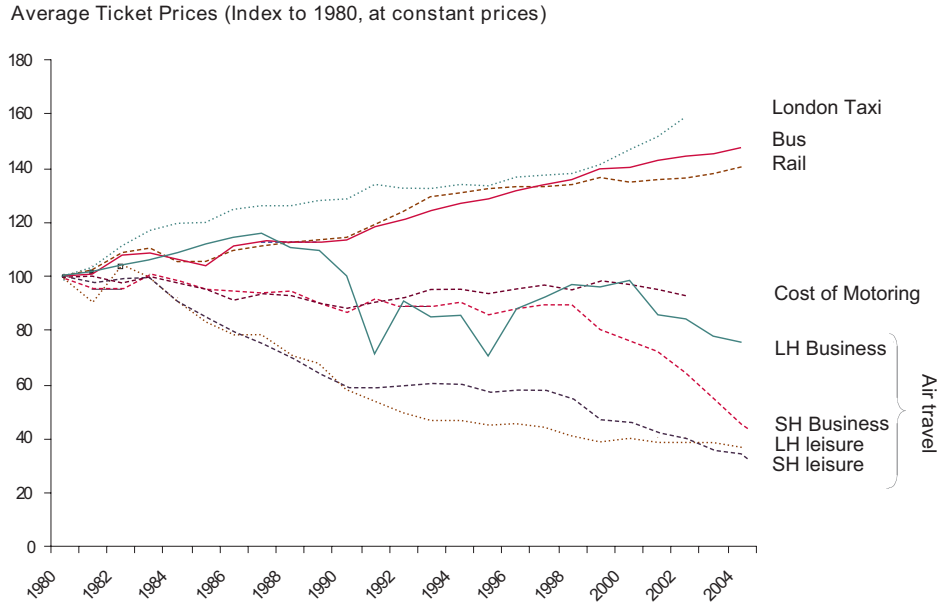
Figure 66 Growth in leisure flights



Note Short haul is anywhere in Western Europe, long haul is anywhere else
Source DfT

This has been driven in part by major, real-term declines in ticket prices of 60-70 per cent in leisure and 40-50 per cent in business air prices. In fact, aviation is the only mode of travel in the UK where costs have gone down in real terms. It is not surprising, therefore, that there has been strong growth in demand.

Figure 67 Changing cost of air travel compared with other modes

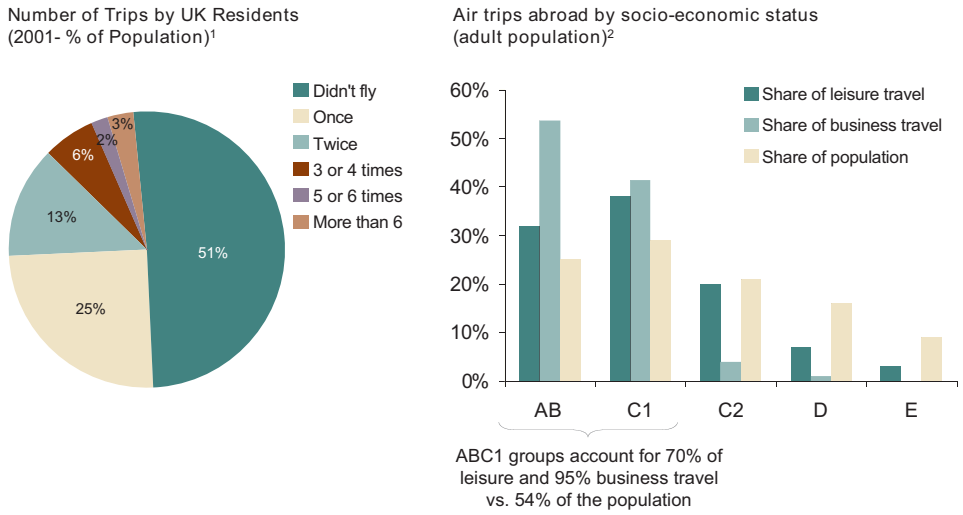


Source DfT

Who flies?

Contrary to popular perception, the majority of air trips are accounted for by a reasonably small percentage of the population. A recent survey of UK residents showed 50 per cent of the population do not fly at all, and 25 per cent fly only once per year. But 10 per cent of the population flies three or more times. Indeed this 10 per cent of the population take fully half of all flights, and 25 per cent of the population take 75 per cent of flights. Rates of air travel are much higher for wealthier people, who are indulging in multiple weekend breaks and more long haul flights each year.

Figure 68 Composition of UK air travellers

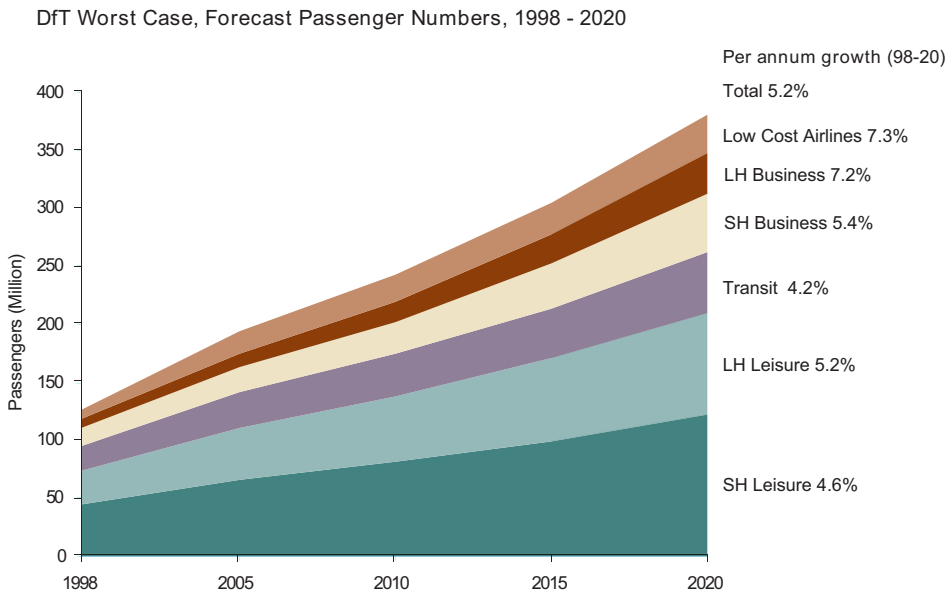


Source DfT; Mintel and CAA Origin & Destination Survey

Where will future growth come from?

In line with trends to date, leisure trips are expected to continue driving growth. Although low-cost airlines have had an impact on the airline industry, they represent a relatively small market share and are not expected to take over from more traditional players.

Figure 69 Forecast growth in passenger numbers



Source DfT

Another key source of growth will be inbound flights from rapidly developing countries. Even over the next two to three years, expected growth rates in air travel for countries such as Poland, China and India are as much as double the anticipated rate of growth in UK air demand.

4.6.4 Summary of potential actions to reduce emissions from air travel

There are a number of possible ways to deliver reductions in CO_2 emissions from aviation. These include:

Improved efficiency of fleet operations

There may be potential to improve utilisation of the existing fleet, for example by increasing the number of passengers carried on each flight and making route patterns more efficient. The current view is that opportunities for improvement in this area are limited (since the airlines have already taken advantage of these kinds of measures) and would not reduce emissions by more than about five per cent. Lower-carbon ground-based movements such as those recently proposed by Sir Richard Branson again should absolutely be pursued, but since they relate only to a small percentage of emissions it is estimated that they would not deliver much more than a five per cent reduction[4].

Low-carbon fuels

Low-carbon fuels that have been developed to date are not appropriate for powering airplanes. For example, the high-energy content but low density of hydrogen would require fundamental changes to jet design and hydrogen's main by-product of water vapour acts as a greenhouse gas at high altitudes. Ethanol is an impractical fuel source for aviation, as its low heat content by volume would require significantly larger fuel tanks and because a low flash point would present a material safety risk.

Possible longer-term options could include either biodiesel or biokerosene. Biodiesel can be mixed with kerosene to form a lower carbon emitting fuel but ratios are limited to 10-20 per cent as it impairs performance at lower temperatures (such as those in the atmosphere). Biokerosene can be manufactured synthetically from biomass (like biofuels for ground transport described in chapter 4.5), but provides less energy by volume that would make its use in long haul flights difficult.

Improvements in engine efficiency

Engine and plane design improvements that reduce fuel consumption, for example by improving an aircraft's power to weight ratio, are continually explored by the industry. Historically these have delivered efficiency improvements of 1-2 per cent per year, but even if the current rate of

improvement continues, these efficiencies are already assumed in baseline projections and are therefore part of the minimum action needed.

This is not to say that technological improvements are impossible - simply that investigations so far have not yielded dramatic changes. With greater incentives to reduce the carbon-intensity of flying, solutions to one or more of the technological barriers described might well be found. For example, experts within the aviation industry suggest that, with the right incentives giving greater priority to these improvements, engine efficiency improvements of 50 per cent from today could be delivered by 2020[5].

These improvements would apply only to new planes entering the fleet, not the vast majority of the fleet that will already be in operation. To deliver meaningful reductions, therefore, improved planes would have to be churned into the fleet at much faster rates than has historically been the case. While these planes could certainly deliver fuel and hence cost savings to the aviation industry, a faster replacement rate could have significant implications for the economics of the industry.

Fiscal measures to incentivise carbon efficiency

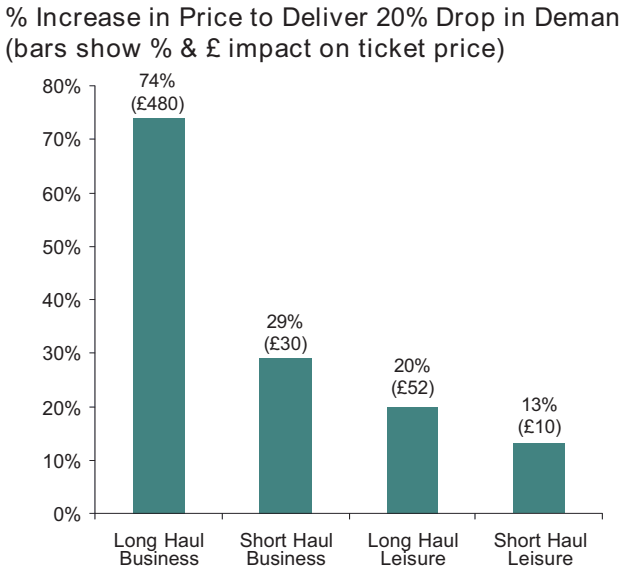
One way to promote greater investment in energy efficiency and alternative fuels is through fiscal incentives. At the moment, the aviation industry is not subject to fuel duty. The incentive to reduce fossil fuel use is therefore lower than in other industries. For example, if the 12.5 million tonnes of fuel consumed by the UK aviation industry were subject to the same duty as motorists pay for petrol or diesel, the annual cost would be almost £8 billion[6].

Two broad options - taxation or carbon trading - could be used to create such incentives.

Taxation alternatives under discussion include taxes per flight, per passenger or on fuel. Whatever approach is taken, taxation would need to drive the right incentives (ie, a tax on flights would only create an incentive to increase passenger load factors, which delivers only a slight carbon-saving opportunity).

The **carbon trading** approach would be delivered most easily by including aviation in the existing EU emissions trading scheme (which currently only covers emissions from large energy-intensive industries). By 2020, the European Commission estimates that a total of 183 million tonnes of CO_2 would be saved annual through such a scheme, a 46 per cent reduction compared with business as usual projections[7].

Figure 70 Historical price/demand elasticity for air travel



Source Bank of Canada; Friends of the Earth

There is substantial evidence that even a slight increase in ticket prices will have an impact on demand, and in particular on incremental, discretionary short-haul leisure flights. Just looking at short-haul leisure, international elasticity suggests that a £10 (13 per cent) average increase in price would deliver a 20 per cent decrease in demand. This is supported by recent survey data, where people were asked what the impact of various price increases would be on their flying habits (30 per cent said a price increase of £20-50 would change their mind about taking a flight to Europe[8]). Ultimately, however, these types of measures will need to be at an EU or international level to avoid affecting one country's competitiveness and to have any significant effect.

Other demand management measures

A more direct measure to manage demand would be to restrict growth in airport capacity. This would increase the value of existing capacity, ensuring that flights with higher economic value were not constrained while reducing some discretionary short-haul leisure flights.

Marketing campaigns can also be used as 'soft' measures to promote behavioural change. These would include making people aware of the impact of flying, promoting leisure destinations that can be reached without flying, and promoting available high-speed rail alternatives.

Finally, developing a high-speed rail network that provides an affordable, competitive alternative to air is important on routes where rail is a viable alternative. Experience in the UK shows that where total rail journey time is even slightly less than air, such as London-Manchester, rail's market share quadruples and rail takes the majority of trips.

Carbon offsetting

For necessary air travel, carbon offsetting is increasingly popular as a way of counteracting the effects of air travel. However, this is less effective than avoiding emissions in the first place. A number of offsetting schemes are available but prices are highly variable and tend not to reflect the true social cost of carbon (on average offset schemes use a value of ~£9/tonne of CO_2, while the true 'social' cost of carbon was estimated by the Stern Review to be £43/tonne[9]). Offsetting schemes should only be used that involve certified emissions reductions (CERs).

4.6.5 Actions already underway to tackle emissions from aviation

The current status of national and international efforts to tackle CO_2 emissions from aviation is alarming.

- There is no agreed framework seeking CO_2 reductions from international aviation. The Kyoto Treaty, for example, does not cover the majority of emissions from aviation. Only emissions from domestic trips (four per cent of total aviation) are included in the UK's CO_2 inventory and as such are covered by current Kyoto Protocol reduction obligations.
- Unlike other areas of transport where alternative engines and fuels are already coming onto the market, there is no substitute to the kerosene-fuelled jet engine on the immediate horizon. In addition, the long lifecycle of aircraft means that improvements will be slow to churn naturally into the fleet.
- Some energy-efficiency initiatives have recently been suggested by the aviation industry. These include lower-carbon ground operations (e.g. towing planes to runways to avoid idling on the ground) and ongoing improvements to engine efficiency. While these are important measures, they will not alone be sufficient to deliver significant carbon reductions or indeed to even offset expected growth.
- Government policy currently supports continued airport expansion through additional runways, more terminals and increased aprons[10]. In the South East, proposals for further runways at Heathrow and Stansted are being progressed. This additional capacity will certainly enable further aviation demand growth to materialise.

4.6.6 Mayor's key priorities for action

The majority of mechanisms that could tackle the future CO_2 impact of aviation are beyond the direct influence of the Mayor. In any case, action will ideally have to be taken on a European or global level to really be effective. Still, the Mayor will do the following to ensure London does its part in addressing this issue:

- **Work with the aviation industry** to implement efficiencies that can deliver a step-change reduction in emissions. The aviation industry has already proposed certain improvements, which should certainly be adopted. In addition, much more radical technological improvements should be developed as quickly as possible, and the Mayor will support much more aggressive exploration of these opportunities.

  As part of London's work with the EU on European-wide research and development collaboration and funding for new technologies, the Mayor will also promote the use of some of these funds for the aviation industry to develop these new technologies. This is a priority for both the Mayor and the industry, since successful delivery of these improvements would substantially reduce the need for other, fiscal measures.

- **Seek to influence EU and international aviation policy.** The Mayor strongly supports the government's position that aviation emissions should be included in the EU emissions trading scheme (ETS) from 2008 and will continue to lobby in support of this. However, there is concern that this change will not occur before 2010 at the earliest. The Mayor will argue for the earliest possible incorporation. Furthermore, this does not include flights to destinations outside the EU, which must be addressed either through a modification to the EU-ETS proposal or through international trading schemes and the Mayor will argue for this.

  Through the C40 Large Cities Climate Leadership Group and other mechanisms the Mayor will seek the support of other European cities to put pressure on the EU to make this change.

  Prior to the EU-ETS mechanism being in place, the Mayor will support the introduction of other fiscal measures to incentivise greater carbon efficiency in the aviation industry and avoid unsustainable growth in low-value flights for the wealthy.

- **Challenge the need for further runway expansion at UK airports.** While it will be of continued importance for London to have excellent international links, existing runway capacity should be used for business flights and a reasonable volume of leisure flights. Given that the majority of growth has been and will be in additional leisure flights for those who already fly a lot, avoiding runway capacity growth will only affect these incremental, discretionary flights.

- **Lobby for fuel duty to be levied on aviation.** As part of measures to ensure flying reflects the cost associated with its CO_2 emissions, the Mayor will lobby the UK government and EU to levy duty on aviation fuel. This will provide further incentive to the aviation industry to deliver greater fuel efficiency.

- **Educate Londoners and advocate alternatives to air travel.** As part of overall communication on climate change, the Mayor will seek to give Londoners and London's businesses information about the impacts of air travel, so they can make informed decisions about flying. Tourism is a very important contributor to London's economy, and the recent rise of low cost airlines has been a factor in bringing increasing numbers of visitors to London, although this has not offset the losses from the domestic market taking increasing numbers of trips overseas. The Mayor will therefore continue to promote the Totally London campaign to encourage Londoners to enjoy tourism leisure opportunities in their own city. In promoting UK and continental European tourism to London, he will promote alternative methods of travel to aviation. He will promote alternatives to leisure destinations reached by air, such as UK and European destinations that can be reached by rail and ferry. The Mayor will also work with government to lobby for the further development of price-competitive, high-speed rail services that can compete effectively with domestic air travel. Where flying cannot be avoided, the Mayor will promote low CO_2 access to airports. For example, on the cost of the Heathrow Express should be reviewed to ensure that it is used to its full capacity.

In general, the Mayor will promote an air travel hierarchy such that individuals

1 avoid flights wherever possible, e.g., by travelling by rail within the UK and to Europe, by making use of video and teleconferencing, and
2 offset air travel only as a means of last resort. The Mayoral family itself will reduce flights to the absolute minimum and will continue to offset the remainder.

References

1 "London's airports" refers to Heathrow and London City. Gatwick, Stansted and Luton are not included as they are located outside the GLA boundary.

2 Flights to and from Heathrow and London City represent about 60 per cent of total UK passenger km. If CO_2 from aviation were allocated to cities on this basis, London's share would be slightly more than 20 million tonnes annually.

3 More information on these effects is available at the Royal Commission website, www.rcep.org.uk

4 Details of the full extent of Sir Richard Branson's commitment as part of the Clinton Global Initiative on climate change can be reviewed at http://www.clintonglobalinitiative.org

5 Signatories to Sustainable Aviation (a group of major airlines, airports and aircraft manufacturers) have targeted improved fuel efficiency and CO_2 emissions of 50 per cent per seat kilometre by 2020 compared with 2000 levels.

6 12.5m tonnes of aviation turbine fuel (or 16 billion litres) were consumed in the UK in 2005. Fuel duty on low sulphur petrol/diesel is currently 48.35p/L

7 Details of the European Commission's assessment of including aviation in the EU ETS may be found at: http://ec.europa.eu/environment/climat/pdf/aviation_ets_impact_sum_sec2006-1685-2_en.pdf

8 Interim results from unpublished survey completed on "Attitudes to Climate Change and Aviation" for the Commission for Integrated Transport, February 2006.

9 Estimate of the social cost of carbon today if we remain on a BAU trajectory. It is higher than estimates used elsewhere because risk is treated explicitly and recent evidence on risks has been incorporated.

10 The term apron refers to the hard-surfaced area surrounding terminal buildings.

5 Tackling Mayoral group CO_2 emissions

5.1 Overview

The Mayoral group itself currently produces around 226,000 tonnes of CO_2 per year, 0.5 per cent[1] of London's total emissions, through its own direct activity. While this is not high, the Mayor believes that public authorities need to practise what they preach and the Mayoral group is committed to:

- **aggressively tackling CO_2 emissions** from its own operations including 75,400 staff, 8,300 vehicles and one million square metres of facilities[2]
- **demonstrating how these savings can be made** in practice by continuing to establish flagship projects to provide best practice examples and proof of concept to London. These examples will also be used to showcase potential CO_2 reduction actions to London's boroughs and municipalities, universities, schools and hospitals sector
- **catalysing the wider market** to increase the supply and affordability of low carbon technologies.

The Mayoral group comprises the Greater London Authority and four functional bodies - London Development Agency, London Fire and Emergency Planning Authority, Metropolitan Police Authority (to whom the Metropolitan Police Service is accountable) and Transport for London. In aggregate, the Mayoral group activity involves 75,400 staff, 8,300 vehicles and one million square metres of floor space.

Achieving CO_2 savings from the Mayoral group will focus on a number of key areas:

- building, refurbishing, and managing its facilities to ensure all buildings are as energy-efficient as possible
- running ongoing staff campaigns such as "switch-off" campaigns to reduce energy use
- moving towards more local energy generation by implementing decentralised energy (CHP and renewables) wherever possible
- maximising green procurement opportunities, including buying only energy-efficient office equipment and where possible using smaller, cleaner vehicles in the Mayoral group's fleet
- reducing air travel to the absolute minimum, and offsetting emissions where air travel is unavoidable.

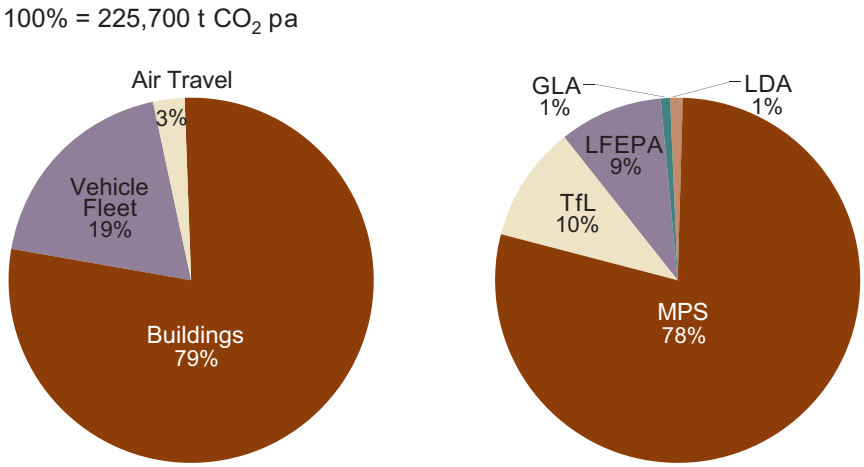
The rest of this chapter covers

- Current and projected emissions from the Mayoral group, including CO_2 reduction targets and an overview of key actions required to deliver the target
- Specific features of the Mayoral group
- Summary of potential actions to reduce CO_2 from the Mayoral group
- Actions already underway to tackle emissions from the Mayoral group
- The Mayor's key priorities for action.

5.2 Current and projected CO_2 emissions from the Mayoral group

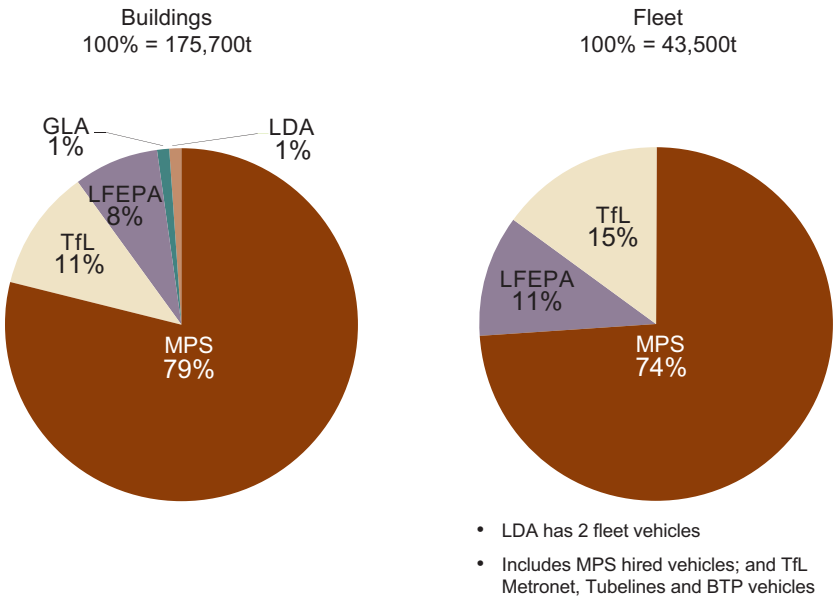
Current emissions. Currently the Mayoral group produces around 226,000 tonnes of CO_2 from its internal operations, including office buildings, fire and police stations, and fleet vehicles (including police and fire emergency response vehicles). Broader Londonwide emissions are considered elsewhere in this document[3].

Figure 71 2006 Mayoral group emissions



Nearly 80 per cent of the Mayoral group's CO_2 emissions are from its buildings, with vehicle fleet and air travel contributing 19 per cent and three per cent respectively.[4] Due to the large size of its building stock and fleet, the Metropolitan Police Service makes up 78 per cent of the Mayoral group's total emissions.

Figure 72 Mayoral group sources of CO_2 emissions



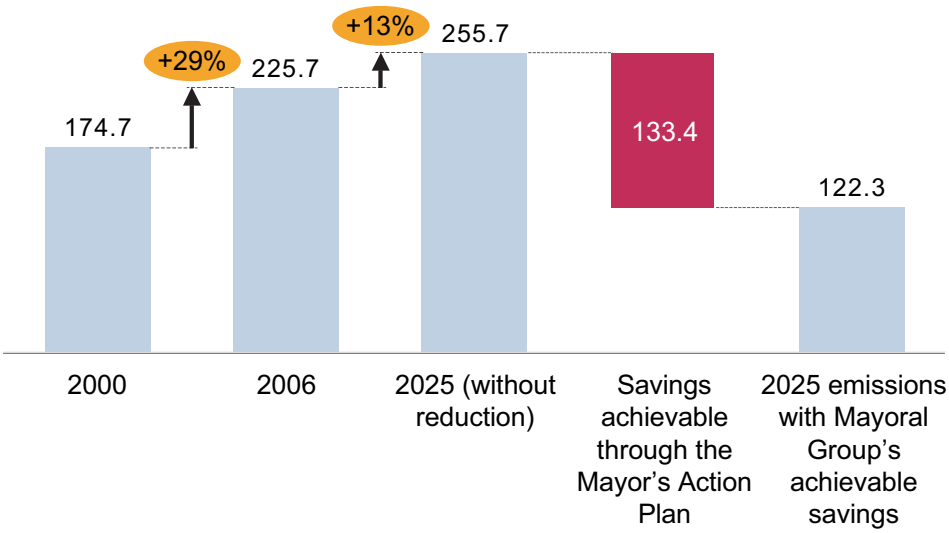
Future emissions (2025)

Without intervention, CO_2 emissions from the Mayoral group are projected to rise to 256,000 tonnes per annum by 2025 (an increase of 13 per cent compared to 2006), driven by projected growth in London (as projected in the draft Further Alterations to the London Plan) and the resultant need to expand public services.

Sectoral target

We do not have data referring to our consumption levels in 1990 since the Mayoral group did not exist so will instead be using the year 2000 as our baseline. Since the year 2000, emissions have grown by 30 per cent, mainly due to a 19 per cent increase in the size of the MPS. The Mayoral group's achievable savings by 2025 amount to circa 133,000 tonnes of CO_2 per annum. This figure would increase if the government meets its targets for reducing CO_2 from energy supply (see chapter 4.4 for more information).

Figure 73 Mayoral group achievable CO_2 savings[5]
Thousand tonnes of CO_2

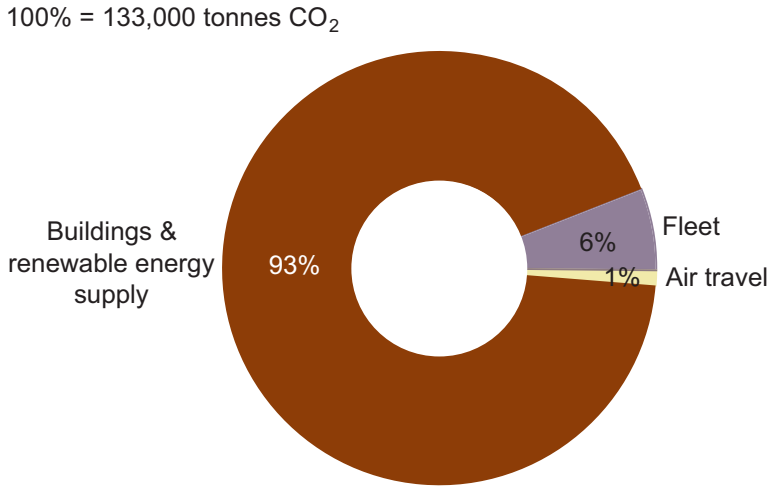


Overview of how the target can be achieved

The Mayoral group is committed to reducing CO_2 emissions from its own operations, not only to deliver its fair share of savings in London, but also to catalyse others do so. The Mayoral group will demonstrate how CO_2 savings can be made in practice by

- reducing our energy use to an absolute minimum through building energy efficiency measures and behavioural change campaigns coupled with introducing decentralised energy (CHP and renewables) could save circa 124,000 tonnes of CO_2 per annum (93 per cent of the target)
- reducing our energy use from vehicles through eco-driving campaigns and a move towards smaller, cleaner vehicles could save circa 8,000 tonnes of CO_2 per annum (six per cent of the target)
- eliminating non-essential air travel needs could save circa 1,000 tonnes of CO_2 per annum (one per cent of the target).

Figure 74 Source of potential savings from the Mayoral group



We have already identified specific actions to capture savings amounting to 48,700 tonnes of CO_2 (37 per cent of the target) and are developing plans to pursue the remainder and we will be pushing to identify and achieve further savings at every opportunity within the constraints of our duty to deliver services for a safe and accessible London.

5.3 Special features of the Mayoral Group

The Mayoral group comprises the Greater London Authority (GLA) and four functional bodies, each with different areas of activity and responsibility. Across the functional bodies, there are around 75,400 staff, 8,300 vehicles and one million square metres of floor space involved in delivery of the Mayoral group's duties.

Functional Body	Staff	Vehicles	Buildings/ Floor space
GLA	600	0	1 building/ 18,500 m^2
LDA	365	2	1 building (3 floors)/ 6,700 m^2
LFEPA	7,190	482	120 buildings (offices, fire stations)/ 159,800 m^2
MPA/MPS	48,270	6,405*	720 buildings (offices, stations, training sites)/ 647,400 m^2
TfL	19,000	1,375**	51 office buildings/ 155,000 m^2
TOTAL	75,425	8,262	893 buildings/ 987,000 m^2

Notes * including hired vehicles
**includes TfL, Metronet and Tubelines support vehicles only, excludes emissions from buses, taxis, London Underground, other transport services including stations and traffic emissions which are included in the transport chapter.

The composition of the functional bodies is varied; MPA/MPS and LFEPA have large numbers of operational sites in addition to head office buildings. Achieving CO_2 savings from these operational sites and from emergency response vehicles represents a different challenge - for example, the operational requirements of emergency-response services may require certain vehicle types to be used. The emissions from TfL vehicles relates to the support fleet used by TfL, Metronet and Tubelines (emissions from TfL's operational fleet including buses, underground and taxis are included in the transport chapter).

The Mayoral group will introduce behavioural campaigns to educate our 75,000 staff and this material will also be used to influence other organisations working with the Mayoral group such as large contractors. In addition, we are in a unique position to engage with Londoners through the services the Mayoral group provides. For example, TfL's buses and underground alone cater for 7.5 million journeys each day, providing an audience for information campaigns.

The Mayoral group is demonstrating how CO_2 savings can be made in practice through continuing to establish flagship projects to provide best practice examples and proof of concept to London. The Mayoral group will exploit its close relationship with London's boroughs and municipalities, universities, schools and hospitals (MUSH) sector to produce additional savings. The MUSH sector produced 4.5 million tonnes of CO_2 in 2006[6], 10 per cent of London's emissions. If the MUSH sector reduced its CO_2 emissions by 30 per cent (in line with proposed Further Alterations to the London Plan targets and what the Mayoral group will deliver), this would deliver 1.35 million tonnes of CO_2reduction (3 per cent reduction off London's overall emissions in 2025).

5.4 Summary of potential actions to reduce CO_2 from the Mayoral group

The Mayoral group can be viewed as a case study for delivering reductions that can be achieved in the commercial and public sectors generally.

The Mayoral group will therefore address its CO_2 emissions from buildings as described for the commercial/public sectors (Chapter 4.2), and from new buildings in line with best practice for new developments (Chapter 4.3). Both current and new Mayoral group buildings will introduce decentralised energy where possible, in line with the Mayor's recommended actions for London's energy supply (Chapter 4.4). The actions described in Chapter 4.5 to reduce emissions from road vehicles will be applied to the Mayoral group vehicle fleets.

The Mayoral group will model best practice in delivering these actions, as well as seeking to trial and catalyse the next generation of technologies as they become available.

5.5 Actions already underway to tackle emissions from the Mayoral Group

There are a number of actions already underway in each of the functional bodies; they are described along with planned future actions in section 1.5.

5.6 The Mayor's key priorities for action

There are five key areas of focus in the Mayoral group

a Improving the energy efficiency of our buildings and appliances including installation of energy efficient lighting and appliances and designing of new building with carbon reduction as a priority. The Mayor will require that all parts of the Mayoral group carry out energy efficiency audits of all their buildings. These should explore opportunities to improve thermal efficiency, reduce the need for artificial cooling.

b Maximising use of decentralised energy and related savings through the installation of CHP, wind, photovoltaics and solar thermal heating at appropriate Mayoral group sites. The Mayor will work with every functional body to explore the opportunities for integrating renewable energy supply into all of their buildings. He will set a target for the total amount of energy that should be supplied by renewable energy by 2015 and 2025.

c Promoting staff energy-savings behaviour at home and at work by running ongoing staff campaigns. A key performance target for all corporate services departments across the group will be to reduce energy intensity year on year.

d Minimising emissions from travel and vehicles, including ensuring all vehicles are smallest, cleanest vehicle appropriate to the task. In addition, all members of the Mayoral group are developing travel plans that follow best practice, focusing on use of public transport and sustainable travel. In particular, they will ensure that cars are only provided to staff where they are operationally essential, and that all such cars are as environmentally friendly as possible. With regard to air travel, the Mayor has already stipulated that all Mayoral group flights should be offset where flights are unavoidable. His preference is to offset into a London fund, rather than through existing schemes; while the details of this are developed, the Mayoral group will offset into the DEFRA offsetting fund.

e Following high green procurement standards for contracting all goods and services.

The Greater London Authority (GLA)

a Building energy efficiency

- The GLA has already taken a number of actions to reduce its CO_2 emissions. We are fortunate that City Hall itself - the GLA's headquarters - was designed as an energy-efficient building. By including borehole cooling, natural ventilation and triple glazed windows in its design, the building is able to operate on only 25 per cent of the energy typically needed to run a high specification office building.

b Decentralised energy

- In early 2007 the London Climate Change Agency (LCCA) will install photovoltaic cells on the roof of City Hall, providing three GWh of renewable electrical power over its lifetime. The LCCA is also investigating the potential for City Hall to become the first building in London to have energy supplied by a fuel cell combined heat and power system. The GLA also procures 100 per cent green tariff electricity.

c Behavioural change

- The GLA has supported self-organised local environmental champions within the organisation, who have conducted ongoing campaigns to conserve energy in day-to-day operations, such as "switch off" for

lights and computers. This has increased levels of paper recycling, by 42 per cent, and reduced energy use by nine per cent through turning off appliances.

- The Mayor has also encouraged a series of events and exhibitions to raise awareness of climate change among GLA staff, including hosting the Climate Group's North-South-East-West exhibition at City Hall, taking over 200 staff to see Al Gore's climate change film "An Inconvenient Truth" and staging the "Future London Show" exhibition outside City Hall.
- The Mayor will pilot at City Hall and then encourage all functional bodies to instigate a regular programme designed to encourage staff to green their lifestyles outside of work. This will include
  - a regular on-site Green Homes advice service
  - advice on intranet pages
  - subsidised offers for low energy products.

d Transport

- The GLA operates a staff Travel Plan and all staff travel to work by public transport, cycling and walking with the exception of some disabled staff. Levels of cycling to work among GLA staff have risen from seven to 10 per cent between 2004 and 2006. The Mayor leads by example and travels to work and most of his engagements by public transport. One of Ken Livingstone's first acts as Mayor was to cancel plans for a chauffeur driven cars for the Mayor and senior Assembly Members.
- The GLA has also greatly increased the provision of secure cycle parking and lockers for cyclists, all floors have showers and free towels are provided, and there is a drying room for wet cycling kit. Interest free loans are available for purchasing cycles, and there are GLA pool bikes for use on work trips during the day.

e Green procurement

- During 2006 the GLA led the development of a group Sustainable Procurement Policy. This policy sets an overarching framework within which members of the group will undertake their procurement sustainably. The policy seeks to address a broad range of social, economic and environmental issues through seven policy strands, one of these being "Promoting Greater Environmental Sustainability."
- Following its launch the GLA has been co-ordinating the implementation of the Sustainable Procurement Policy across the group. To maximise the benefit of the group's purchasing power, implementation of the policy includes a focus on the development and use of appropriate contractual and relationship management tools to drive positive sustainable practices through GLA group supply chains.

- The GLA is signed up to the highest level of the Mayor's Green Procurement code (level B2).
- The GLA has a policy of purchasing recycled printer and photocopier paper.
- As part of its ongoing IT hardware replacement programme GLA purchases equipment that is produced sustainably and minimises its impact on the environment.

The London Development Agency (LDA)

a Building energy efficiency

- The LDA has moved recently to Palestra (see photo opposite), a building selected for its "very good" BREEAM rating[7] (Building Research Establishment Environmental Assessment Method).

b Decentralised energy

- The LDA has installed an 80kWp capacity combined wind (comprising 14 turbines) and photovoltaic system on the roof, the first building in London to have both wind and PV.
- The LCCA are providing advice and support to the functional bodies in identifying and delivering decentralised energy
- The LDA purchases green tariff electricity.

c Behavioural change

- The LDA's printers hold printed documents in a queue until the individual enters their pin code on the printer itself. This limits wasted printing. Printers are all set to double- sided copying.
- The LDA has desktop power sockets to encourage staff to switch off appliances and mobile phones chargers.
- The LDA is currently carrying out a staff travel survey following the office move, prior to developing a staff travel plan.
- The LDA has introduced new recycling points for white, mixed, confidential paper, plastic and glass bottles and drinks cans, CDs and batteries.
- They have introduced a bin-less office policy that encourages recycling. All staff members have only paper recycling containers at their desks. The LDA recycling rate is 70 per cent (on average).

d Transport

- The LDA's only fleet vehicle is LPG-dual fuel.
- The LDA provides showers, secure cycle parking and locker facilities.
- The LDA discourages taxi use. There is no taxi account so any taxi use has to be approved and claimed back.

e Green procurement

- LDA purchases recycled office stationery and Evolve Paper (100 per cent recycled paper). White paper collected is sent to a mill in Kent that is owned by M-real. This is then made into paper such as Evolve and in turn the LDA purchases Evolve and so completes the loop.
- LDA publications are made of recycled material.
- 97 per cent of LDA new furniture spend has been made on recycled content products.
- Energy efficiency built into new IT equipment (energy star compliance).

© LDA

The London Fire and Emergency Planning Authority (LFEPA)

a Building energy efficiency

- LFEPA has installed automatic lighting controls to reduce energy consumption and made insulation improvements at a number of locations.
- Started a programme of replacing lighting (luminaries) at all stations with high frequency fittings.
- LFEPA have revised design standard for fire stations to reduce appliance bays' minimum ambient temperature from 10ºC to 5ºC.
- BREEAM assessment of all LFEPA new buildings and major refurbishments.

b Decentralised energy

- LFEPA has completed a number of projects to install micro-renewable technologies at seven sites, including solar photovoltaic cells, solar water heating and CHP.
- LFEPA also purchases 100 per cent green tariff electricity.
- Photovoltaic cells are to be installed on up to 20 sites.
- Wind turbine systems are to be installed on up to 40 LFEPA sites.
- CHP systems are to be installed in up to 31 LFEPA sites.
- Solar thermal systems are to be installed on up to 20 sites.
- LFEPA's plans will not only reduce carbon emissions, but also provide a highly visible advertisement for these technologies.

c Behavioural change

- The Brigade Mobilising Centre that handles all 999 calls took part in the CIBSE 100 days of carbon campaign and achieved a 6 per cent reduction over that period.
- LFEPA is also implementing an energy awareness campaign for staff.
- LFEPA are currently developing a travel plan.
- Climate change guidance has been incorporated in new employee induction programme and crew manager/ watch manager training programme.

d Transport

- LFEPA's vehicle replacement programme was introduced to take advantage of the newest and cleanest technologies on the market. Since 2002, LFEPA has reduced emissions by 250 tonnes despite an increase in its fleet. On a CO_2-emissions-per-vehicle basis, the reduction achieved to date is just under 24 per cent.
- LFEPA has approval for use of bio diesel, up to five per cent.

e Green procurement

- LFEPA is ensuring all IT equipment purchase is energy efficient.
- LFEPA procurement team activities are undergoing ISO 14001 certification.

The Metropolitan Police Authority and Metropolitan Police Service (MPA/MPS)

a Building energy efficiency

- The MPS has a £4.6 million programme in place that installs more efficient heating, cooling and lighting systems in its poorly performing buildings. The programme includes boiler replacement, insulation, improved glazing and building energy use controls.
- The MPS is accredited by the Carbon Trust's Energy Efficiency Accreditation Scheme.
- The MPS have committed to Making a Corporate Commitment Campaign 2 (MACC2) - three per cent savings target was met in second year of participation.
- The MPS is committing to a series of new carbon emission reduction targets, aiming to reduce CO_2 emissions by 10 per cent by 2010 and then 30 per cent by 2025.
- All new MPS buildings will meet the highest specification for energy efficiency possible. Office accommodation will meet BREEAM very good or excellent standards. The proposed five new MPS custody centres will utilise renewable technologies such as ground source heat and solar water heating to generate the optimum CO_2 savings.

b Decentralised energy

- The MPS also purchases 100 per cent green tariff electricity.
- New MPS developments will include decentralised energy where appropriate.

c Behavioural change

- Energy awareness campaigns will be rolled out to MPS staff encouraging turning off lights and electrical equipment. All MPS computers automatically switch off at 7pm each day.
- Environmental awareness is promoted at the MPS Corporate Induction.

d Transport

- The MPS has operates a detailed vehicle selection process, which ensures the smallest and cleanest vehicle is used that is appropriate for the task.
- The MPS has a rapid programme of vehicle replacement, which includes use of leased vehicles, means that that environmental performance improvements can quickly churn into the fleet.
- The MPS currently runs 15 electric vehicles, 44 Liquid Petroleum Gas (LPG) vehicles and 118 hybrid petrol/electric vehicles.
- The MPS driver training includes efficient driving techniques that improve fuel efficiency. MPS drivers are trained to drive efficiently when not responding to emergencies.

- The MPS has 1,000 bicycles used for operational duties by offices and plans to increase this by 20 per cent in 2006/07. Further promotion and staff training is planned for 2007/08.
- A salary sacrifice scheme will be implemented whereby staff can purchase reduced price bicycles for travel to work.
- A free Oyster card is provided for all Police Officers.
- An employee travel plan is being developed including travel surveys and development of initiatives to reduce employee car use such as car sharing and promotion of cycling and walking.

e Green procurement

- The MPS is participating in the Green Computing initiative, which looks for opportunities to make environmental savings through IT and includes specification of energy efficient technology.
- The MPS includes sustainability criteria as part of its procurement evaluation processes.
- The MPS is a signatory to the Mayor's Green Procurement Code and commits to increasing the proportion of recycled and environmentally responsible goods and services in its supply chain.

Transport for London (TfL)

a Building energy efficiency

- TfL received a 2006 Energy Efficiency Accreditation Scheme award, recognising TfL's commitment to energy efficiency in head office buildings
- TfL uses a combination of passive designs and technology to improve energy efficiency. It has installed a number of ceiling and window shading systems to reduce overheating in hot weather and reduce cooling needs.
- TfL's heating plant is being upgraded as part of a rolling programme to install high efficiency condensing boilers.
- The majority of its lighting is automatically controlled by occupancy and daylight sensors.
- TfL has also implemented detailed head office energy use monitoring systems and advanced metering.

b Decentralised energy

- A photovoltaic system has been installed at the London Transport Museum which represents the largest PV installation on a listed building in the UK.
- 100 per cent of TfL's electricity for buildings is green tariff.
- TfL is exploring other opportunities to integrate photovoltaic cells and wind turbines into TfL buildings.

© London Transport Museum

- TfL is developing a plan to improve the BREEAM standard of Palestra to "excellent" as part of its future role of main lessee.

c Behavioural change

- Energy awareness campaigns have been implemented, including participation in the CIBSE 100 Days of Carbon Cleanup campaign.
- Ongoing campaigns are underway through a variety of internal communications mechanisms including staff magazines and the intranet

d Transport

- TfL's support fleet includes 22 hybrid vehicles and 102 dual fuel LPG vehicles, and it planning to make further investment in low-carbon vehicles in future through the London Transport Hydrogen Project.
- TfL will introduce an eco-driving campaign, including the dissemination of information on fuel-efficient driving and the introduction of driver training programmes.
- A travel plan is in place to encourage continued use of public transport, and to increase levels of walking and cycling.
- Secure cycle facilities and changing facilities are available to staff in all suitable buildings, bicycle loans are also available to staff.
- Free Oyster cards are provided for all TfL staff.

e Green procurement

- A green procurement code is in place.

Across the Mayoral group

- The GLA and each Functional Body are developing a revolving fund in order to provide money for a rolling programme of building energy efficiency improvements over the coming years. Savings generated from building energy efficiency measures will be returned to the fund to pay for future energy efficiency measures.
- In total in 2007/08, the Mayoral group has more than £10m available for reducing CO_2 emissions. This includes:
  - £5.4 million for TfL, £5m of this is part of a £25m fund over the next 3 years. In addition, TfL has £400k in 2007/08 to fund energy efficiency measures on TfL buildings
  - £2.3 million for LFEPA, part of a £4.4 million fund over the next three years to fund energy efficiency measures and install renewables on LFEPA buildings.
  - £1.15m for MPS, part of a £4.6 million fund over the next three years to fund energy efficiency measures on MPA/MPS buildings.
  - Circa £1.6 million for GLA, to install photovoltaic cells and solar shading at City Hall and CHP (subjected to feasibility study).

  - £0.15 million for the GLA to manage a coordination programme aimed at ensuring each Body within the Mayoral group delivers its own emissions reductions.
- Finally, a number of energy working groups have been established across the functional bodies to share best practice and to support implementation such as the GLA Group Cleaner Transport Forum and Energy Managers Group.

References

1 TfL's CO_2 emissions from buses, taxis, London Underground, other transport services including stations and traffic emissions are included in the transport chapter. Only TfL's support vehicle fleet is included in this chapter. CO_2 emissions for LDA-led developments are covered in Chapter 4.3 on new development.

2 A further 25,000 staff are employed by companies contracted to run London's 8,200 buses, under regulation by the Mayor. How we will reduce emissions from these operations is set out in Chapter 4.5.

3 TfL's CO_2 emissions from buses, taxis, London Underground, other transport services including stations and traffic emissions are included in the transport chapter. Only TfL's support vehicle fleet is included in this chapter. CO_2 emissions for LDA-led developments are covered in Chapter 4.3 on new development.

4 More than 80 per cent of the Mayoral group's air travel is taken for operational purposes by the MPS, for example trips include police investigations associated with the Indian Ocean tsunami and the 7/7 bombing, and diplomatic and Royal protection.

5 The rise in emissions between 2000 and 2006 is largely due to a major increase in police numbers.

6 MUSH (based on floor space) accounts for 25 per cent of commercial sector emissions. Municipal is 7.5 per cent, Universities & Schools are 12.5 per cent and hospitals are five per cent of commercial sector emissions.

6 BREEAM assesses the performance of buildings in the following areas - building management, energy use (including CO_2), health and wellbeing, air and water pollution issues, transport-related CO_2 and location-related factors, land use (green/brown-field sites), ecology, environmental implication of building materials and water consumption and water efficiency.

6 Monitoring and review: our ongoing commitment

The Mayor will report annually on London-wide CO_2 emissions and progress against the targets set out in this Action Plan. This will be done as part of the Mayoral Group budget and business planning process. Progress in implementing these actions and delivering CO_2 reductions will also be reported in the following publications and reports:

- Annual review of progress against Mayor's Energy Strategy
- Mayor's State of the Environment Report
- London Sustainability Development Commission annual performance indicators
- TfL annual Environment Report, monitoring performance against TfL's environmental performance indicators
- LFEPA Environment Update & Monitoring Annual Report monitoring performance against LFEPA's Environmental Action Plan
- Metropolitan Police Environment Report.

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