



LU Carbon footprint report 2008



Foreword

The Tube provides one of the most carbon efficient forms of transport. London's Underground system is intensively used, enabling 3-4 million fast, efficient journeys around the capital every day.

If all these journeys were made by car, the additional 2.5 million more cars on the roads everyday would increase congestion and add 1.3 million tonnes to London's annual Carbon Dioxide (CO₂) emissions.

The Mayor of London has set ambitious reduction targets to reduce carbon emissions by 60 per cent by 2025 from 1990 levels. Increased use of public transport is a large part of the solution, and the LU's upgrade programme increases peak capacity into central London by almost a third.

While the average car journey within London is responsible for the release of 138g CO₂e¹, the average Tube journey results in the generation of just 48g CO₂e, making the Tube one of the most carbon efficient forms of new transport capacity.²

LU can also contribute by improving our own carbon efficiency. LU's electricity consumption in 2007/2008 was 0.4 per cent of all the electricity used in the UK and 2.8 per cent of London's total usage,

making LU the largest consumer of electricity in the capital.³

The starting point is to fully understand our carbon footprint. This report has been prepared using the best practice GHG Protocol methodology. This is the most comprehensive estimate of the LU carbon footprint yet prepared. It includes the emissions resulting from LU's use of electricity and other fuels, and supporting activities such as waste management, staff travel and, where possible, the emissions of LU's contractors.

LU's total carbon footprint in 2007/2008 was 754,437 tonnes CO₂e. Carbon emissions from electricity use accounts for 82 per cent of total emissions, two thirds of which arise from train services. Litter and other waste makes up five per cent of the total, however the benefit of recycling saved around 150,000 tonnes CO₂e, emissions which would have been released had this waste gone to landfill.

This report sets out the detail behind these headline numbers, and some of the proposals we have to improve the Tube's carbon efficiency.

Richard Parry
Director of Strategy and Service Development

¹ Carbon Dioxide, Methane, Nitrous Oxide, Hydrofluorocarbons, Perfluorocarbons and Sulphur Hexafluoride.

² London Residents Travel Survey (2001).

³ Department of Energy and Climate Change (2008). Energy Trends.

1 Introduction	6	7 Scope 3 Carbon emissions	38
1.1 Climate change – the business imperative	6	7.1 Infraco activities	38
1.2 Climate change – risks and opportunities for London Underground	8	7.2 Waste and recycling	40
1.3 A low carbon solution for London	10	7.3 Transport related emissions	42
1.4 Adaptation to climate change	12	7.4 Infraco road vehicles	43
2 Carbon footprint	14	7.5 Rail replacement bus services	44
2.1 Green tariff electricity	15	7.6 Business travel	46
3 Carbon footprint results 2007/2008	16	7.7 Employee commuting	48
3.1 Comparison with other metros	18	7.8 Purchased materials and end use products	50
4 Measured carbon footprint	20	7.9 Water and wastewater	52
4.1 Scope 1 carbon emissions	20	8 Conclusions	54
4.2 Scope 2 carbon emissions	21	8.1 A comprehensive carbon footprint	54
4.3 Scope 3 carbon emissions	22	Appendix GHG protocol Methodology	56
5 Scope 1 Carbon emissions	24	The Greenhouse Gas Protocol Initiative	56
5.1 Purchased gas	24	Designing the GHG Inventory	58
5.2 Greenwich Power station	26	Greenhouse gas emission categories	60
5.3 Company leased vehicles	28	Emission causing activities	62
6 Scope 2 Carbon emissions	30	Emission factors	64
6.1 Traction electricity	30		
6.2 Non-traction electricity	32		
6.3 Stations	33		
6.4 Depots	35		
6.5 Head offices	36		
6.6 Reducing Scope 2 Carbon Emissions	38		

1 | Introduction

1.1 Climate change – the business imperative

The cost of not acting to mitigate and adapt to climate change will be five to 20 times the cost of dealing with the problem... There is still time to avoid the worst impacts of climate change, if we take strong action now.⁴

This report sets out, as comprehensively as possible, London Underground's total carbon footprint, as a vital first step in taking forward proposals to improve the Tube's carbon efficiency. LU will publish further reports on its carbon footprint as part of the process of tracking improvements.

Climate change is emerging as one of the great challenges for modern society. The basic mechanics of climate change are well understood; the world is warming, much of the warming is due to human emissions of greenhouse gases, and the changes are set to accelerate in the future, bringing many and varied impacts around the world.

Global emissions of the 6 Kyoto greenhouse gases⁵ increased by 70 per cent between 1970 and 2004 with the transport sector contributing a 125 per cent growth in emissions, second only to the energy supply sector.

Over the past 140 years the earth's surface temperature (over land and sea) has increased on average by $0.6 \pm 0.2^\circ\text{C}$ with the greatest increases occurring in the second half of the last century. The 1990s were the warmest years in recorded history.

Although this rise in temperature may appear small, it is scientifically significant and does have dramatic impacts on climate, for example Northern Europe is predicted to become wetter and the Mediterranean drier.



⁴Sir Nicholas Stern, *The Stern Review*, 2006.

⁵Carbon Dioxide, Methane, Nitrous Oxide, Hydrofluorocarbons, Perfluorocarbons and Sulphur Hexafluoride.

1.2 Climate change – risks and opportunities for London Underground

At the company level, implementing climate policies can draw attention to money-saving opportunities.⁶

In today's commercial environment organisations are susceptible to a number of risks of which climate change is only one. In the coming years, the impact of climate change upon businesses will grow significantly as governments adopt more progressive strategies to encourage efforts to reduce and manage carbon emissions.

Addressing, monitoring, managing and reducing carbon emissions, particularly where reductions in energy use are achieved, not only delivers great environmental benefits, but also immediate cost savings. Effective climate change mitigation is also important for the longer term finances of any organisation, taking into account factors such as reputation, risk management, carbon management and environmental responsibility.

In addition to the environmental benefits associated with reducing LU's carbon emissions, there are significant economic benefits for organisations that implement effective carbon management and mitigation measures. Currently, more than £1bn of the annual energy bill for the UK's businesses is wasted.⁷

Managing resources, protecting an organisation's corporate reputation and controlling the cost of compliance with new regulations all make good business sense.



⁶ Sir Nicholas Stern, *The Stern Review*, 2006.

⁷ The Carbon Trust. (2004) *Growing businesses throwing away £1 billion in wasted energy*. Press release.

1.3 A low carbon solution for London

LU can play a key role in providing a low carbon transport system for London. Travelling by Tube is almost three times better in terms of carbon emissions than travelling by car in the capital.

LU is keen to maintain its position as a low carbon transport provider for London and to continue to implement measures that will increase our efficiency and reduce our overall carbon impact. LU is making major investments to meet London's growing demand for transport which will help encourage modal shift and move people away from higher carbon transport options, such as cars, to public transport.

The line upgrades programme will give London and our customers a world class service. This means an advance in reliability, capacity and quality of service.

However, the line upgrades and increased train frequencies necessary to deliver the increase in passenger capacity will result in increased energy demand and associated carbon emissions. LU has established, is currently implementing and also continuing to explore innovative methods and techniques that can be applied to ensure that we are as efficient as

possible with the energy that we use and how renewable technology can be applied to power our operations wherever possible.

We have already been working to reduce our carbon footprint:

- Improved energy efficiency from 750V electricity supply plus the application of regenerative braking on the Sub-Surface Lines Upgrade will reduce the forecasted energy impact by 35 per cent, saving up to 10,000 tonnes CO₂ each year
- Regenerative braking capability on the new Victoria line rolling stock will reduce the potential energy increase by 24 per cent saving nearly 7,000 tonnes CO₂ every year

Other work includes a strategy to source a higher proportion of LU's energy from low carbon sources, provision of automatic meter reading, and the trialling of low carbon technologies at our stations and depots.



1.4 Adaptation to climate change

No business can expect to take decisions knowing everything for certain, and climate change embodies the same dilemmas on a global and long-term scale.

One approach is to focus chiefly upon adapting to climate change, reducing or abandoning efforts to limit emissions as being just too difficult. There are however several limitations to relying on adaptation as the prime strategy. It can be extremely hard to predict exactly what one is trying to adapt to.

Perhaps the biggest problem with an 'adapt-only' strategy is the extent to which it may simply store up more trouble for the future. The great majority of scientists believe that the most dramatic potential impacts of climate change can still be avoided. After a few more decades of unchecked emissions growth (by wholly relying upon an adaptation strategy), that might simply no longer be possible.

Policymaking nearly always requires judgement in the face of uncertainty and climate change is no different. Taking no action is itself a decision, adaptation is certainly required, but it is not credible as a standalone alternative to tackling the root problem of rising global emissions.

In 2006 we developed an outline Adaptation to climate change strategy and during 2007/2008 we identified activities which may be vulnerable to changes in the climate and are working to minimise that risk. We will continue to work closely with the London Climate Change Partnership Transport Working Group to ensure that the transport system in London is prepared for climate change.



A carbon footprint is the total emissions of carbon dioxide and other greenhouse gases (GHGs) in terms of carbon dioxide equivalents (CO₂e) for a defined system or activity.

This report measures the total contribution of LU to climate change and identifies where the biggest carbon impacts and the potential costs and savings occur.

There are two key differences between the previous carbon footprint and this report which explain the increased level of emissions. Firstly this report has applied a best practice methodology, which has introduced of a wider scope of emission sources. The inclusion of more emission causing activities has led to a rise of in the region of 80,000 tonnes CO₂e.

Secondly in June 2008, the Department of Environment, Food and Rural Affairs (Defra) amended its guidance for voluntary reporting purposes to include all carbon emissions from renewable energy procured via green tariffs. Under the previous guidance LU counted the emissions from these sources as zero. The change in carbon accounting has meant LU calculating the carbon emissions from the renewable tariffs it purchases at the standard electricity emissions factor which has increased LU's footprint by 100,242 tonnes CO₂e.

2.1 Green tariff electricity

LU currently procures green tariff electricity for supply to its offices, stations and depots.

Despite the benefits of purchasing renewable electricity, there is significant uncertainty regarding the additional environmental benefit of the green electricity tariffs on offer. In essence, there is a question whether these tariffs achieve any new renewable capacity or carbon saving beyond that created by regulation. In addition, there are concerns about potential double counting of the carbon benefit from renewable generation.

In light of these concerns, for voluntary reporting purposes, the Defra recommends that organisations calculate emissions

from renewable tariffs using the average electricity emissions factor for the UK. In addition, for the purposes of carbon footprinting of products, services, companies or their supply chains, the Carbon Trust does not consider renewable tariffs as "zero carbon" at present and therefore when calculating emissions from renewable tariffs the standard electricity emissions factor should be used.

Following the guidance detailed above, the 2007/2008 LU carbon footprint report includes all carbon emissions from the electricity used at offices, stations and depots.

3 | Carbon footprint results 2008

754,437 tonnes CO₂e

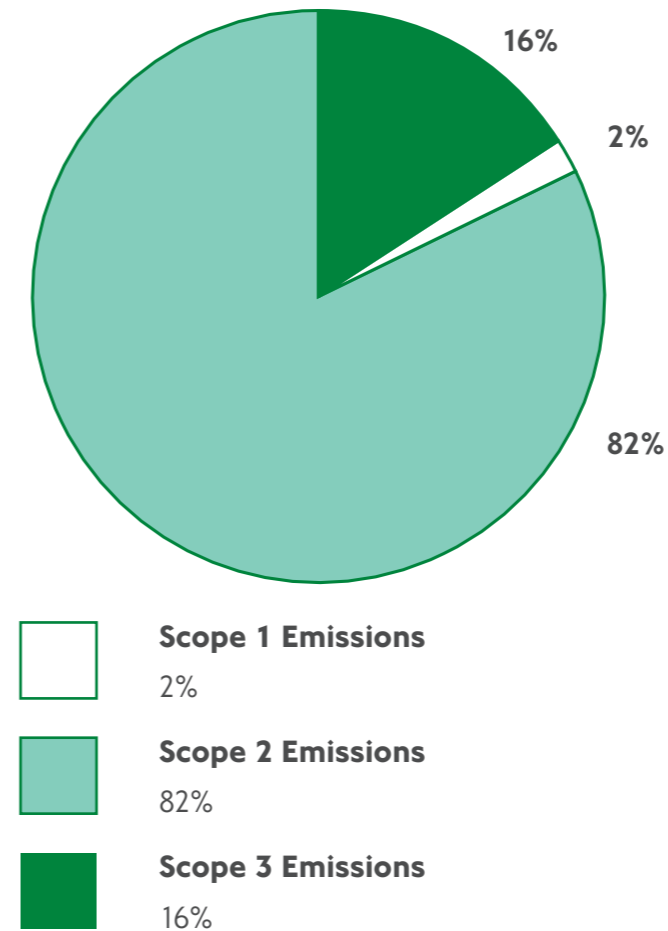
In 2007/2008 London Underground's carbon footprint was equivalent to a total of 754,437 tonnes CO₂e which equates to 93 grams CO₂e per passenger kilometre.

The majority of LU's carbon emissions result from purchased electricity consumption. LU is the largest consumer of electricity in London and one of the top ten electricity users in the UK. The total annual electricity consumption is just over one terawatt hour (TWh) each year which is enough electricity to power over 250,000 households per year.

The Infraco activities carbon emissions shown in the table opposite do not fully include all of Metronet's activities. Data was unavailable for 2007/2008. Metronet will be included in future reports and past results may be revised accordingly.

Footprint component	CO ₂ emitted per annum (tCO ₂)
Scope 1 Emissions	14,156
Purchased gas	8,798
Power Station gas	4,263
Power Station oil	634
Company leased vehicles	461
Scope 2 Emissions	619,000
Purchased electricity	619,000
Scope 3 Emissions	121,281
Water consumption	216
Wastewater discharge	38
Waste produced	34,872
Employee commuting	497
Business travel	718
Rail replacement buses	1,521
Infraco vehicles	2,567
Purchased materials	1,775
Infraco activities	76,670
End use products	2,407
Total	754,437

London Underground carbon footprint 2007/2008



3.1 Comparison with other metros

A recent report published by Imperial College⁸ compared the carbon footprints of the worldwide Community of Metros (CoMET). The assessment compared the CoMET members by calculating the carbon emissions arising from traction power and the electricity used in their stations and depots. This total was then converted to grams CO₂ per passenger kilometre, the results are shown next.

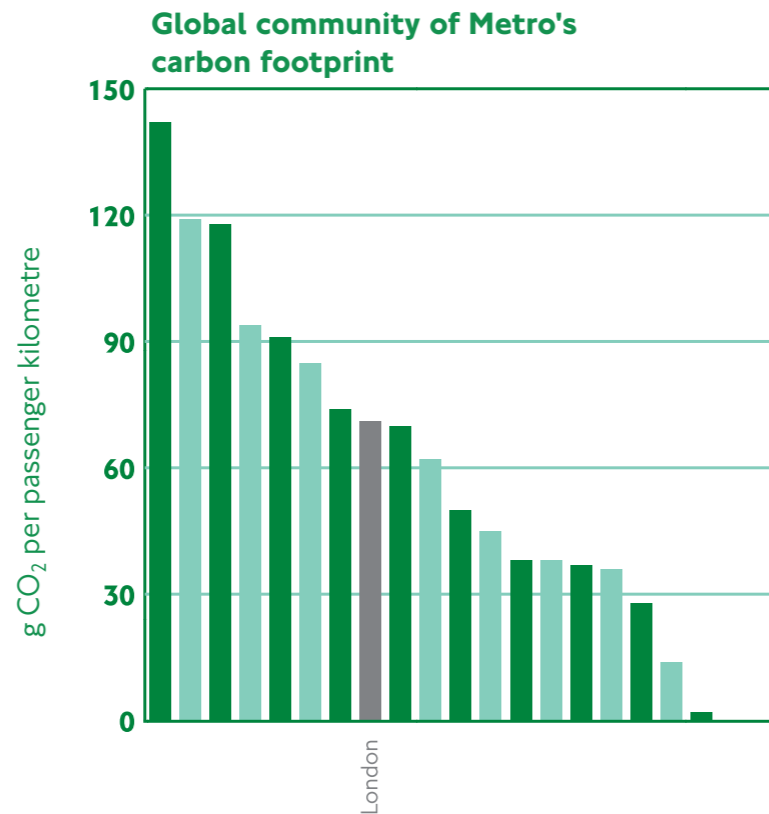
emitted due to a higher provision of nuclear power generation within the two countries. In São Paulo, the CO₂ impact of the metro is negligible as almost all of the area's electricity is provided by hydroelectric power. If the UK national electricity emission factor was the same as in France, LU would be the third most carbon efficient metro in the CoMET group.

The carbon footprints were found to vary for three main reasons:

- 1 Different system characteristics (Metros with heavily-graded networks)
- 2 Train loading patterns (Metros that exhibit high passenger numbers)
- 3 National electricity emission factors and electricity grid mix

All of the metros that have a lower operational carbon footprint than LU are located in countries/areas that also have much lower electricity emission factors.

The relatively high levels of coal and gas that are used in the UK to generate electricity drive the nation's electricity emission factor up, whereas in Paris and Toronto, comparatively low levels of CO₂ are



For confidentiality reasons, the names of the other metro systems have not been displayed in the graph above.



⁸ Imperial College. (2008) *Keeping Metros Competitive – Cost and Carbon Footprint*. Case study – Interim Report.

4 | Measured carbon footprint

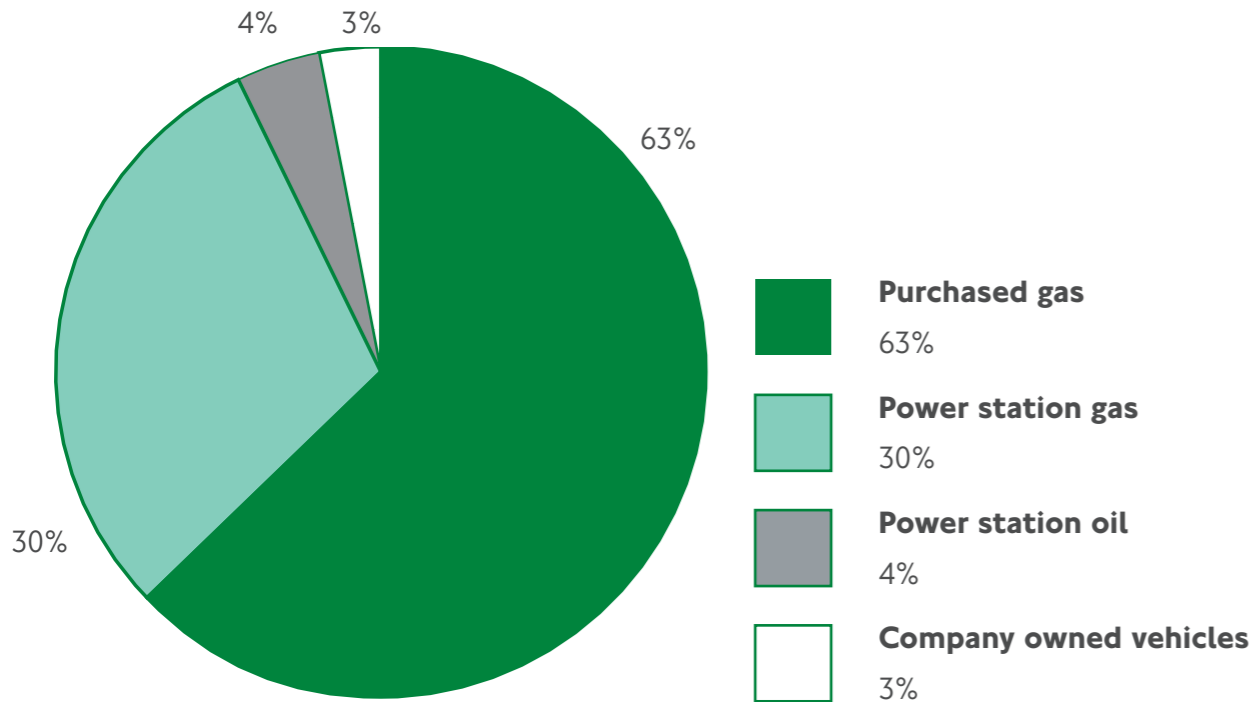
4.1 Scope 1 carbon emissions

14,156 tonnes CO₂e

Scope 1 carbon emissions are the direct emissions that result from activities which LU control. The emissions arise from the combustion of fossil fuels at

Greenwich power station, the burning of gas to provide heating for LU's stations, offices and depots and the use of fuels in company owned vehicles.

Scope 1 carbon emissions



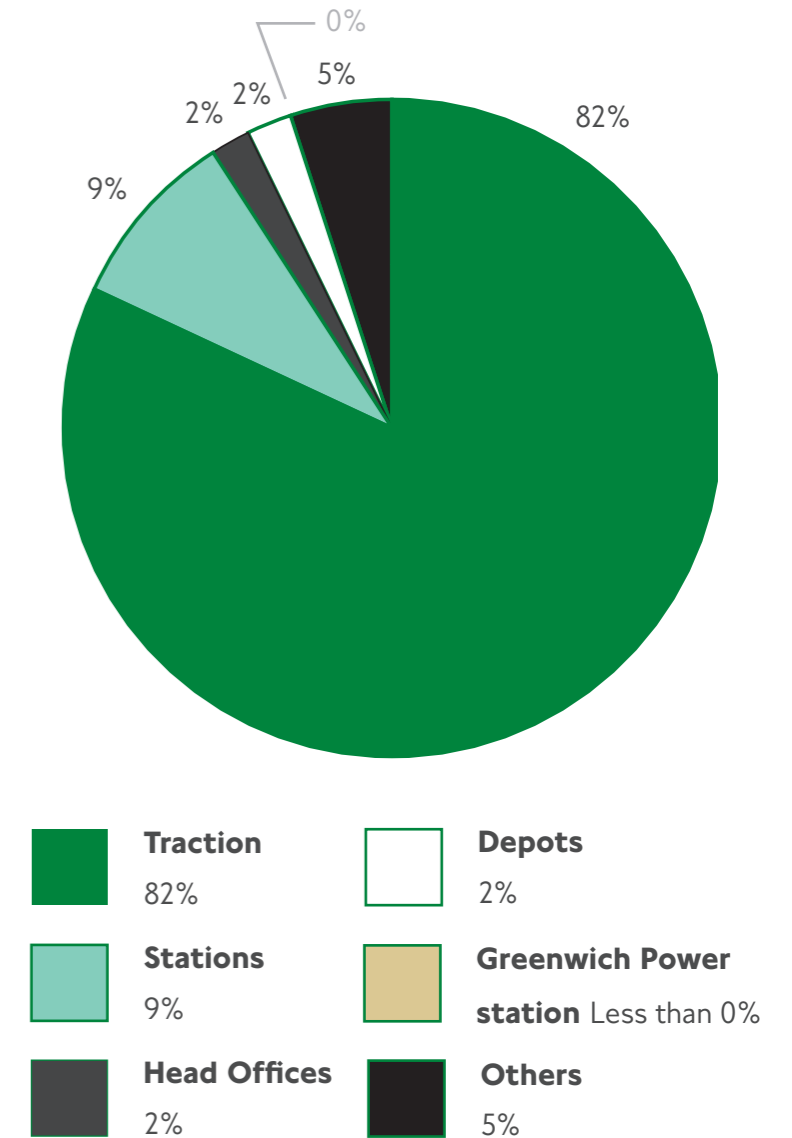
4.2 Scope 2 carbon emissions

619,100 tonnes CO₂e

Scope 2 carbon emissions arise from LU's operational electricity consumption. The carbon emissions associated with the electricity consumed to power the LU trains forms the largest part of the organisation's operational carbon footprint. As part of LU's broader climate change strategy, the organisation aims to reduce the carbon emissions associated with the electricity it uses. Carbon emissions from Scope 2 emissions currently account for 82 per cent of LU's total footprint.

Drivers for LU to mitigate the impact of purchased electricity consumption are rising energy prices, funding pressures, power infrastructure costs, energy market volatility, security of supply and good environmental performance.

Scope 2 carbon emissions



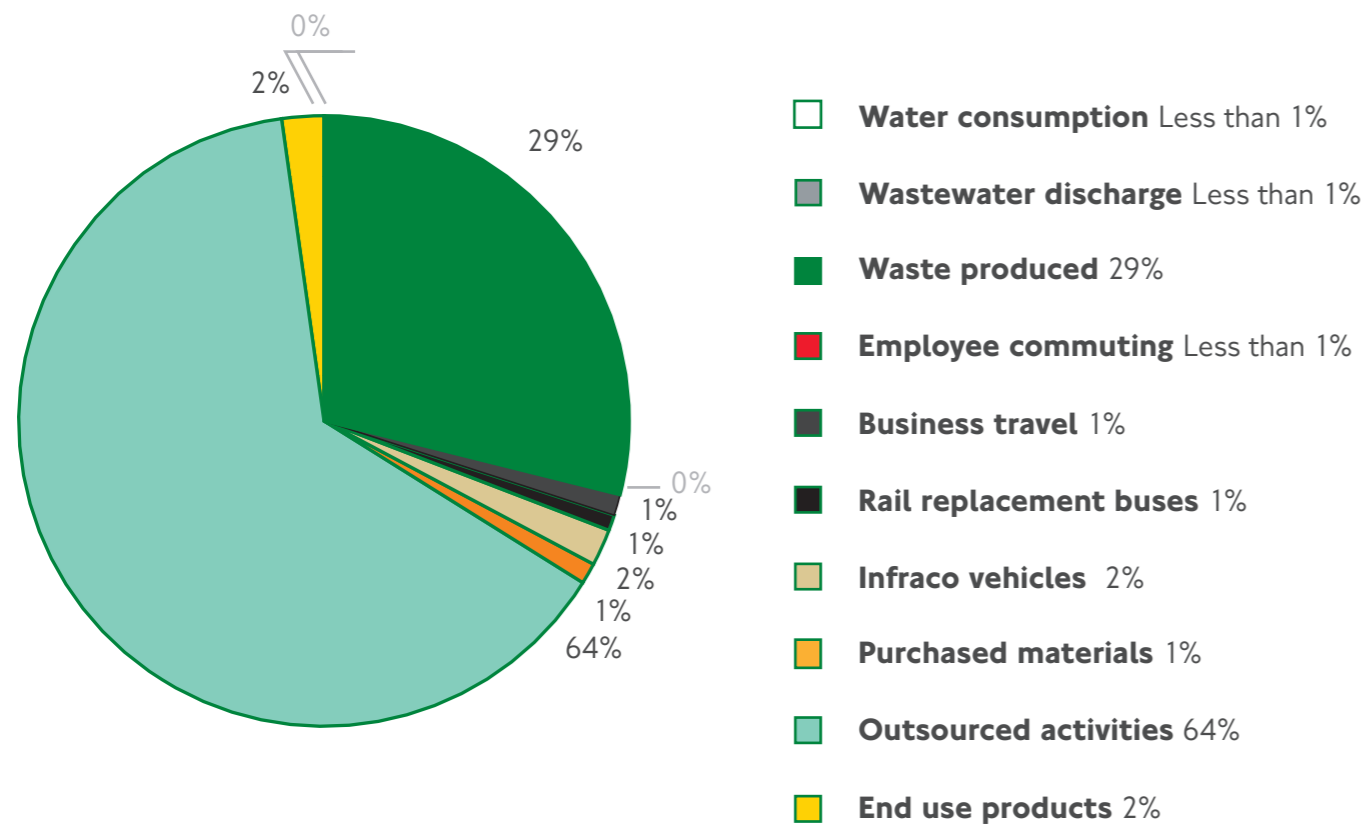
4.3 Scope 3 carbon emissions

121,281 tonnes CO₂e

Scope 3 carbon emissions are from activities that are relevant to LU but are not within the organisation's direct control. The GHG Protocol methodology considers the quantification of Scope 3 emissions as optional when preparing an

overall corporate GHG inventory. However, relevant sources of emissions have been included as part of the LU carbon footprint as they represent a significant impact and present a considerable opportunity to reduce them.

Scope 3 carbon emissions



5 | Scope 1 Carbon emissions

5.1 Purchased gas

8,798 tonnes CO₂e

The carbon emissions from purchased gas were enough to fill nearly 50,000 double-decker buses.

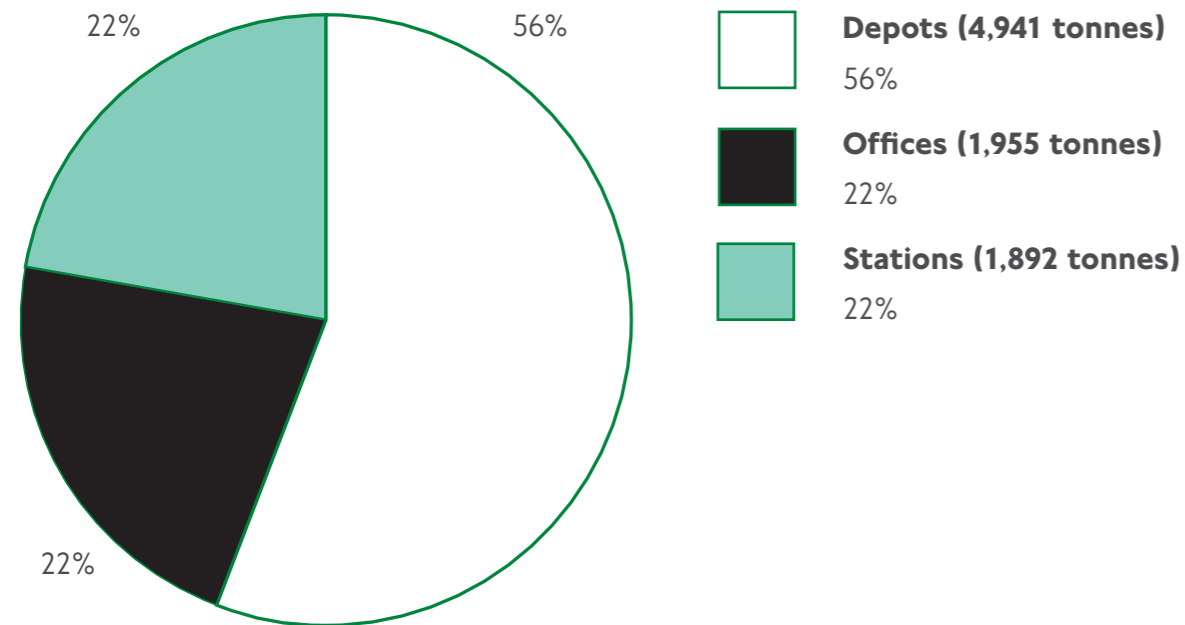
Gas-fired heating systems in depots, offices and stations are the most significant source of direct carbon emissions at LU. LU recognises that there is a large opportunity to reduce this impact in terms of both resource consumption and associated carbon emissions.

The site breakdown highlights the different level of gas consumption across the organisation. There are sixteen main depots on the

LU network giving the capacity to stable trains, clean rolling stock and carry out maintenance activities. Operating 24 hours per day, the depots require heating to enable this work to be performed.

The majority of LU stations that require a gas supply for heating purposes are surface stations; many of LU's sub-surface stations do not have a gas supply for health and safety reasons. Gas consumption at a total of 98 stations has been included within the carbon footprint; the top-ten stations are shown below.

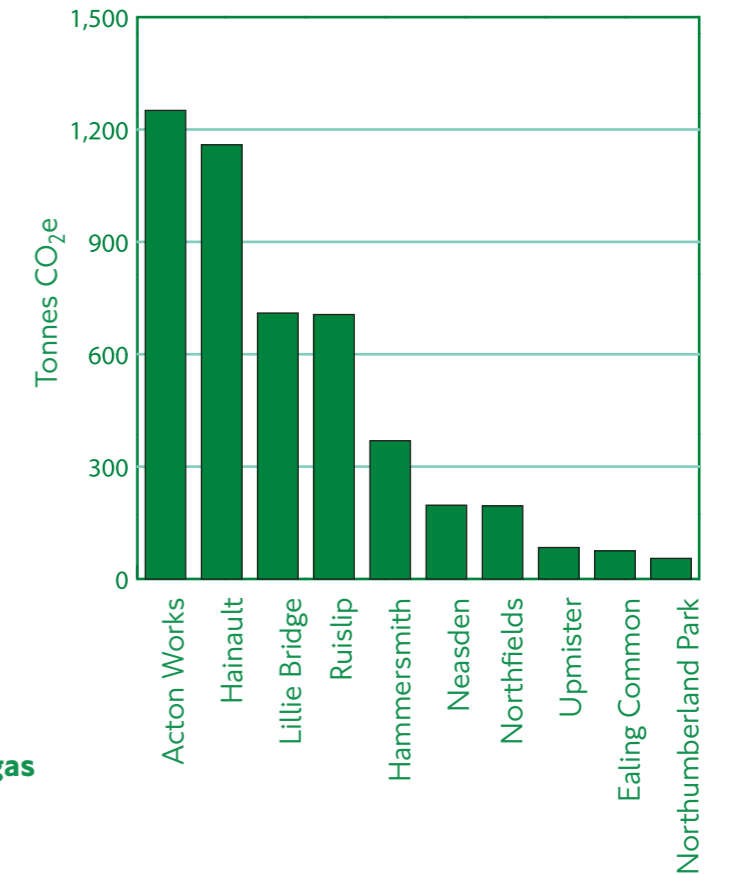
Carbon emissions purchased gas



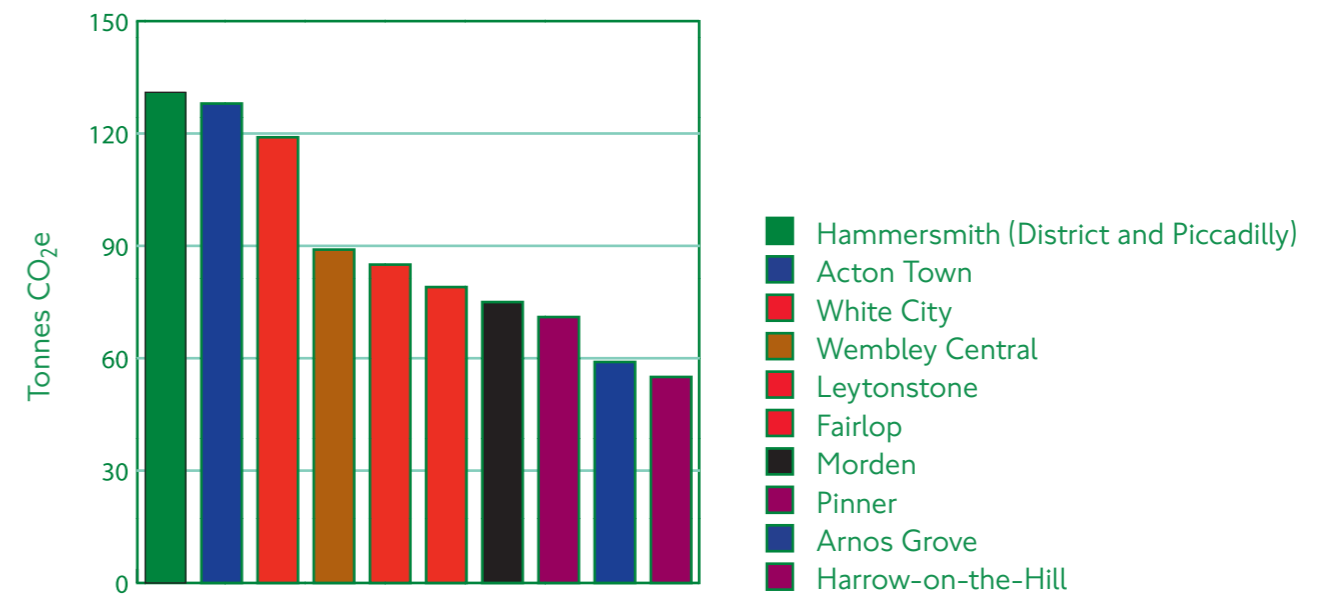
Options that may be considered to reduce the amount of natural gas consumed at LU are:

- Highlight efficiency areas for natural gas consumption and formulate a staff engagement awareness programme
- Investigate new technologies for power supply and heating
- Work to improve data accuracy and submission frequency

Carbon emissions from natural gas consumption at depots



Carbon emissions from natural gas consumption at stations



5.2 Greenwich Power station

4,896 tonnes CO₂e

Greenwich power station emitted enough carbon dioxide to fill more than 1,000 hot air balloons.

Originally a coal-fired power station, Greenwich was built between 1902 and 1910 in order to supply electricity to the London Tram Network. Today electricity is generated by eight Rolls Royce Avon gas turbine engines which were installed between 1967 and 1972. These engines are fuelled by natural gas and are also capable of running on fuel oil which is stored as an emergency reserve at the site.

Greenwich power station serves as a backup power supply for LU to

fulfil its legal obligation to ensure that there are two different sources of electricity for the system. The power generated at Greenwich is predominantly used to provide power in the event of a failure of supply from the National Grid to the LU bulk supply points (BSP).

The power station does not generate enough electricity to sustain a normal operating service but is adequate for essential lighting and services for the evacuation of passengers. It also provides support when a BSP is undergoing maintenance.

Greenwich power station carbon emissions	
Emission source	Tonnes CO ₂ e
Natural gas	4,263
Fuel oil	634
Total	4,897



5.3 Company leased vehicles

461 tonnes CO₂e

The majority of the road support fleet used for LU activity is leased from the PPP suppliers and is accounted for in the Scope 3 emissions section.

However, LU does lease a small fleet of 147 vehicles which emitted a total of 461 tonnes CO₂e. In 2007/2008 emissions from the LU-controlled road fleet were 30 per cent lower than the previous year, mainly due to a reduction in the number of vehicles in our fleet.

All new and replaced LU vehicles are Euro IV compliant, meeting the requirements of London's new Low Emissions Zone.

LU is currently developing plans for improving the carbon emissions from its road fleet including targets, driver and maintenance guidance, and route planning which will help deliver strict carbon emission reduction targets.

Company leased vehicles carbon emissions	
Emission source	Tonnes CO ₂ e
Petrol	226
Diesel	235
Total	461



6 | Scope 2 Carbon emissions

6.1 Traction electricity

518,857 tonnes CO₂e

Traction electricity demand represents the most significant source of carbon emissions for our activities as an organisation. The power required to operate the rolling stock across the network accounts for 68 per cent of the total emissions associated with the LU carbon footprint.

All of the traction electricity is procured from the National Grid and is supplied to the railway via a number of BSPs across the network.

Although the total carbon emissions in this section are termed as traction electricity, a proportion of this power is also supplied to 1,030 groundwater pumps that operate continuously, removing 30 million litres of water per day. In addition, a share of this electricity is also used to power the 126 mid-tunnel ventilation fans across the network and the signalling system.

The line upgrade investments described earlier in this report will deliver more train services and improved customer environments – but will result in an increase in energy demand.

We have been working to reduce the future impact of the line upgrades in terms of carbon emissions by ensuring the application of energy efficiency measures on both the Victoria and Sub-Surface Lines.

The implementation of the energy efficiency measures described earlier are projected to mitigate the increase by approximately 17,000 tonnes CO₂e.

We improved traction energy efficiency reducing the traction energy used per passenger journey from 938 Mega Watt hours (MWh) per million passenger journeys in 2006/2007 to 901 MWh/million passenger journeys in 2007/2008. This improvement was achieved by carrying 6 per cent more passengers while only using 2 per cent more

Carbon/energy efficiency opportunities of the Line upgrades

As part of The Carbon and Energy Management project at LU, this policy paper has highlighted the energy and carbon saving opportunities in the line upgrade programme. The paper detailed a number of engineering processes that could be applied to the line upgrades to reduce carbon emissions including; regenerative braking, automatic train regulation, energy-efficient signalling and redesign of the last delivered upgrade to ensure no net increase in energy or CO₂ emissions.

traction energy. Our traction energy efficiency target for 2008/2009 is 870 MWh/million passenger journeys and LU is currently on target to deliver this.

Bulk supply point electricity distribution

Emission source	Tonnes CO ₂ e
Traction	473,491
Groundwater pumps	36,339
Ventilation fans	9,027
Total	518,857

Traction energy efficiency

Year	MWh/Million passenger journeys	% Reduction
2005-06	1,000	-
2006-07	938	6%
2007-08	901	4%

'Each average passenger journey on the Tube releases 48g of CO₂e from traction electricity. The average car journey within London is responsible for the release of 138g CO₂e making the Tube one of the most carbon efficient forms of new transport capacity'.

6.2 Non-traction electricity

Total emissions: 100,242 tonnes CO₂e

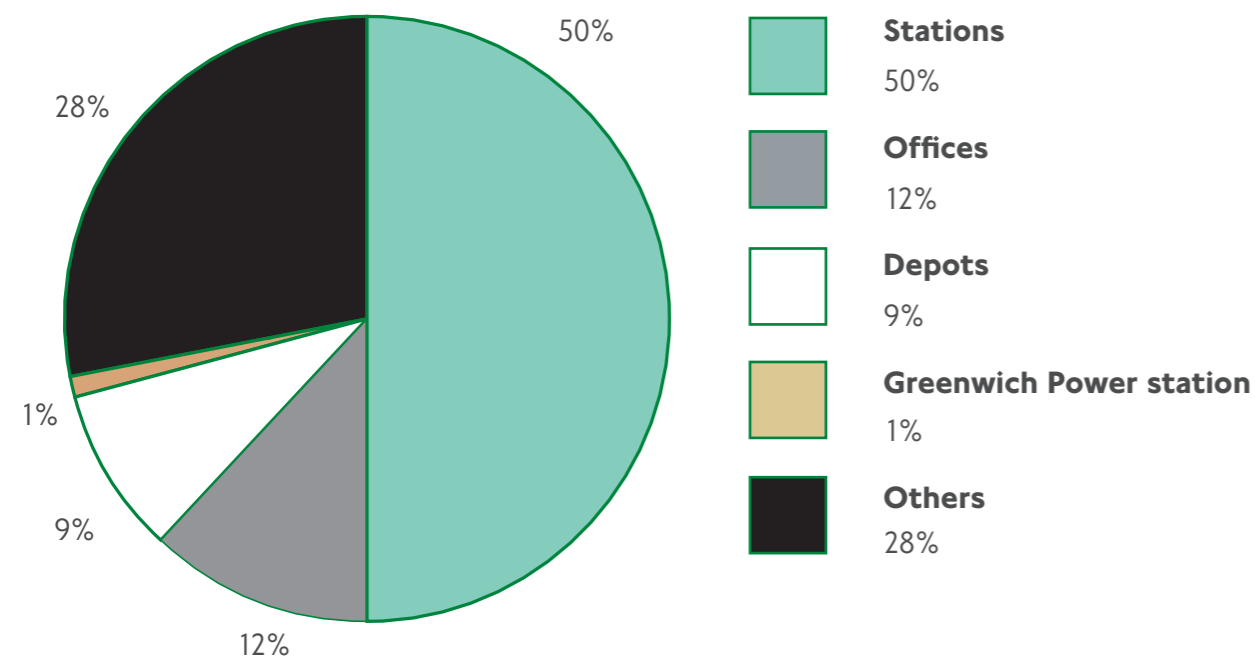
The second highest source of carbon emissions at LU is the electricity consumed for non-traction purposes. This is electricity utilised at stations, head offices, depots and other operating facilities.

The electricity that LU purchases for non-traction requirements is procured as green tariff where the energy is generated from renewable

sources. However, following the recent change in government guidance on calculation of carbon dioxide emissions, the CO₂ impact of the non-traction electricity has been calculated using the National Grid rolling average emissions factor.⁹

Actions in our Carbon Emissions Reduction Plan¹⁰ will mitigate the impact of our activities on our carbon footprint.

Non-traction electricity carbon emissions (tonnes CO₂e)



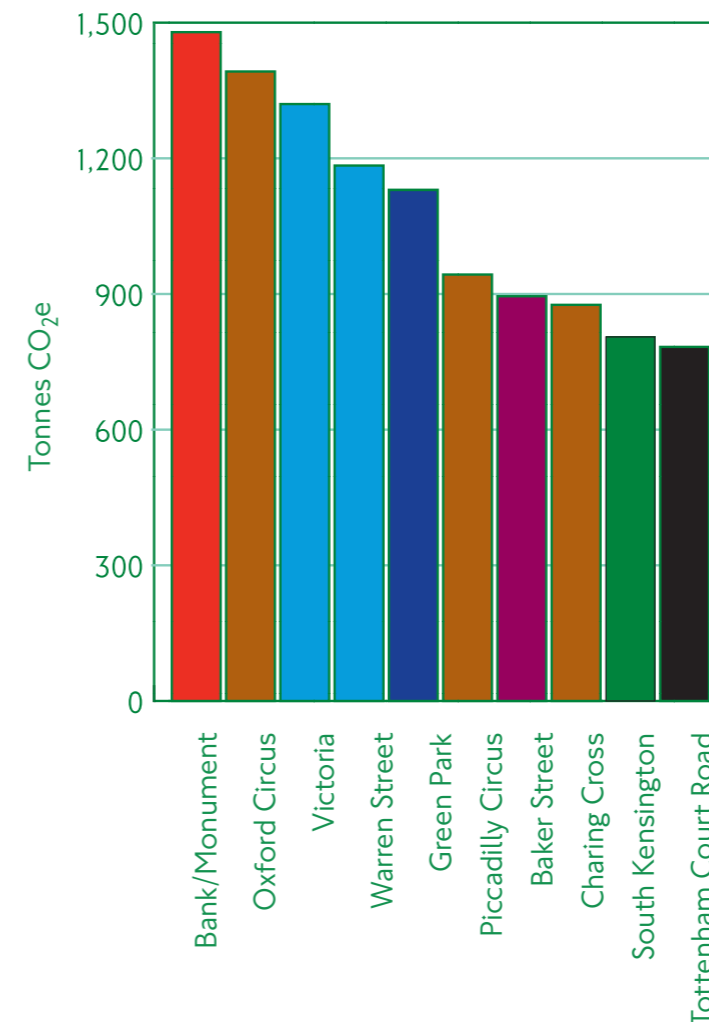
6.3 Stations

53,286 tonnes CO₂e

There are 270 stations on the LU network and their electricity consumption accounts for half of the carbon emissions arising from non-traction usage. The stations consume electricity for lighting car parks, ticket halls, passageways and platforms and also to power ticket gates, escalators, lifts, information and advertising screens.

There are 412 escalators across the LU network. The amount of electricity used by an escalator varies depending on how long it is and how far it rises but as a guide will cost in the region of between £7,000 and £12,000 each year.

Carbon emissions from electricity consumption at stations



Metering strategy

During 2008, LU developed a metering strategy that highlighted opportunities to improve the quality of metered data that LU manages. LU will also investigate the potential for installing the capability for automatic meter reading (AMR) at key stations across the network.

Some LU stations, particularly those on the Jubilee line extension have not been included due to lack of available data.

⁹ The Carbon Trust. (2008). *Carbon Trust publishes views on Green Tariffs*. Press release.

¹⁰Transport for London. (June 2008). *How we are reducing our carbon emissions*.

Low carbon station project

21 technologies that could reduce carbon emissions on LU stations and save costs have been identified.

A feasibility study commenced in late 2008 to conduct studies into each of these technologies. This will result in LU having accurate information on the costs and benefits of each technology. The study will also provide information on the costs and programme for future works.

This study is funded by TfL's Climate Change Fund.

Low carbon energy sourcing strategy

The recently approved Energy Sourcing Strategy sets out an approach on energy supply including considerations for renewable energy and how onsite renewable generation could be implemented at the organisation to provide green electricity for the business. There is a particular focus on both combined heat and power (CHP) and wind energy, both of which are recommended for further and more detailed investigation.

Neasden depot redevelopment

Neasden depot, the largest depot on the London Underground network, is due to undergo a major redevelopment as part of the Sub Surface Line upgrade.

The depot handles the inspection, maintenance, cleaning and stabling of trains as well as a number of administrative functions and a training centre.

LU is implementing low carbon measures within the redevelopment of Neasden depot. The project will not only avoid direct and indirect carbon emissions resulting from activities at Neasden it will also raise the carbon efficiency of future depot redevelopments by promoting and developing sustainable technologies.

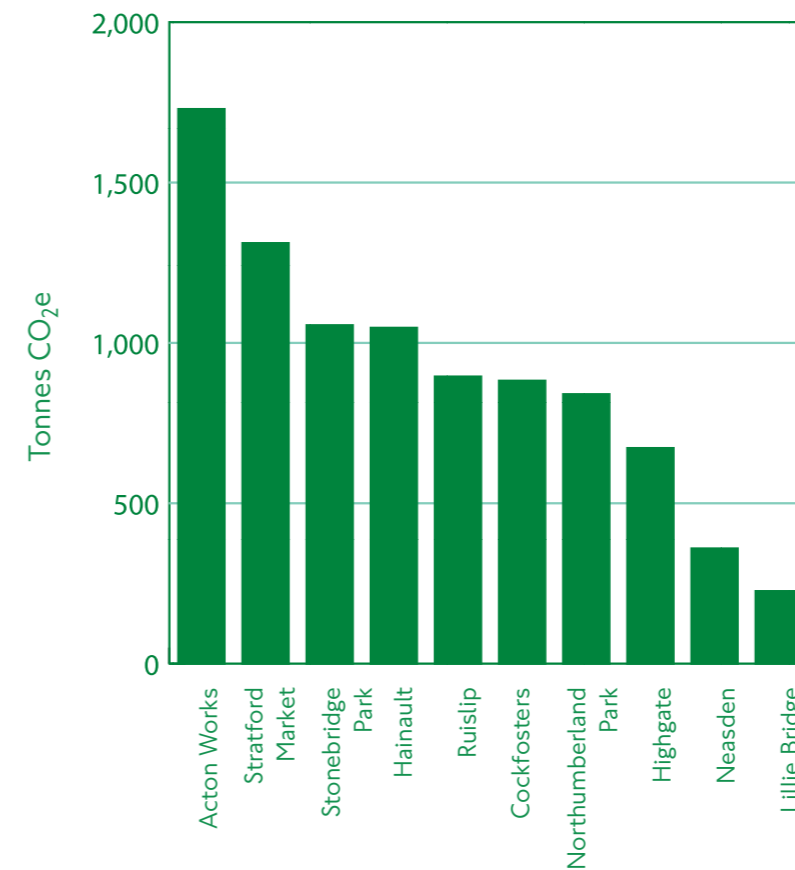
Four other LU depots are due for refurbishment over the next five years and the aim is to make Neasden depot an exemplar carbon efficient depot and LU will look to implement low carbon initiatives in future depot redevelopments to bring significant carbon reductions.

6.4 Depots

9,378 tonnes CO₂e

The 16 LU depots are operational for 24 hours each day and utilise electricity for lighting, heating, mechanical equipment and assets such as roller-shutter doors.

Carbon emissions from electricity consumption at depots



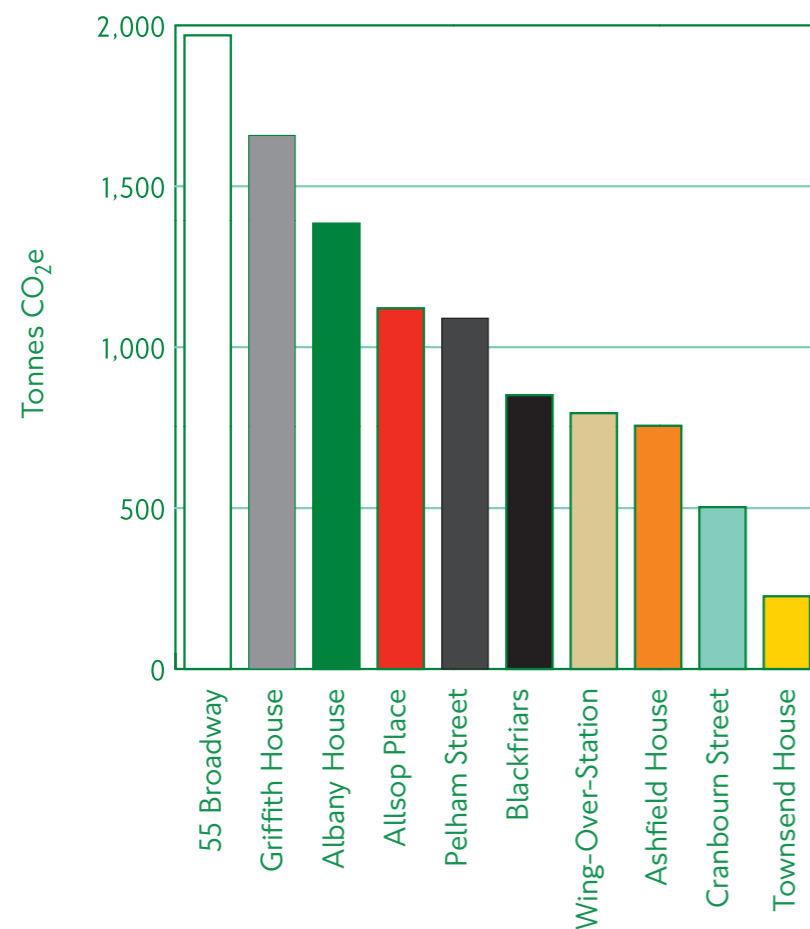
6.5 Head offices

7,547 tonnes CO₂e

Apart from stations and depots, LU employees occupy 25 other premises across London and these consume electricity for typical office functions such as lighting, information technology and kitchen equipment.

TfL's Group Property and Facilities team continue to develop initiatives that will reduce carbon emissions that are associated with electricity consumption at its head offices over the long-term. These include investing in energy efficient equipment, monitoring out-of-hours electricity consumption and promoting staff awareness campaigns.

Carbon emissions from electricity consumption at head offices



Energy Pledge

Launched on World Environment Day 2007, the Energy Pledge aimed to raise awareness of energy efficiency amongst staff and to deliver electricity savings across the company.

Employees across Transport for London (TfL) were invited to 'pledge' to carry out an energy saving behaviour every day for six months.

Hundreds of London Underground employees signed up to the pledge during the six-month campaign. At head offices, electricity use fell by 9% compared to the previous year. In total, this resulted in a saving of over 990 tonnes CO₂.



Energy station challenge

Re-launched in 2008, the Energy Station Challenge (ESC) is a station-based initiative that aims to encourage LU station staff to reduce their total energy consumption via a competition. Stations are awarded points based on their total energy savings when compared to the same period in the previous year. In 2008, a network of Line Energy Champions were installed to promote energy saving at a line level and the year also saw the re-launch of the ESC newsletter, which is emailed to all station staff at the end of each period.

7 | Scope 3 Carbon emissions

7.1 Infraco activities

76,670 tonnes CO₂e

The majority of LU's infrastructure services were outsourced under the Government's Public Private Partnership (PPP) in 2003.

LU remains the network operator and therefore responsible for the day-to-day running of the service. Under the PPP contracts the infrastructure companies, or Infracos, are responsible for the maintenance and renewal of the majority of LU's assets – the rolling stock, stations, track, tunnels and signals.

The carbon emissions of the processes performed by the infracos, such as track replacement,

materials use, waste generation and the transport of materials and people to and from site count as Scope 3 emissions.

Both Tube Lines and Metronet have calculated independent carbon footprints from which this data has been sourced. Due to differences in the scope of the two carbon footprints, they cannot be directly compared.

Tube Lines have made a full assessment of its carbon footprint and included 34 processes across its business that contribute to LU's indirect carbon emissions.

Metronet undertook to identify their carbon footprint as part of a Carbon Management Programme, in partnership with the Carbon Trust. For 2006/2007 they identified and measured the Scope 1, 2 emissions as well as key Scope 3 emissions, such as water use, waste removal and disposal. Certain business processes for example track replacement, have also been assessed.

Metronet became a subsidiary company of TfL in May 2008. We are now working to extend the same carbon footprint methodology across all the

Metronet activities so that future reports are comprehensive.

The PPP and the circumstances surrounding Metronet's transfer to TfL are described in LU's PPP Report.

7.2 Waste and recycling

34,872 tonnes CO₂e

The Carbon Emissions Reduction Plan set out actions for managing carbon associated with our activities, one of which was to examine the carbon emissions associated with how LU manages waste.

A wide variety of wastes are produced as a consequence of operating, maintaining and investing in the LU service. These wastes include customer waste, station and depot waste, office waste, maintenance waste and waste associated with station, track and infrastructure projects. The amount of greenhouse gases which resulted from LU's waste

management activities in 2007/2008 was 34,872 tonnes CO₂e. The carbon footprinting exercise took into account the emissions saved through our recycling efforts.

In 2007/2008, with the support of the PPP contractors, 40 per cent of waste from our stations, depots and offices was recycled (mainly paper). This is a significant increase in the proportion of material recycled (up from 31 per cent in 2006-07) and in the absolute tonnage of material recycled (up from 3,680 tonnes in 2006-07 to 6,027 tonnes in 2007-08). In addition, 71 per cent of all construction and demolition waste was recycled.

Recycling waste in 2007/2008 saved the equivalent of 150,000 tonnes CO₂e which would have been produced if this material had been sent to landfill. Working with our PPP suppliers (who manage waste at our stations and depots and waste from project and maintenance works) we have increased the amount of material that is recycled.

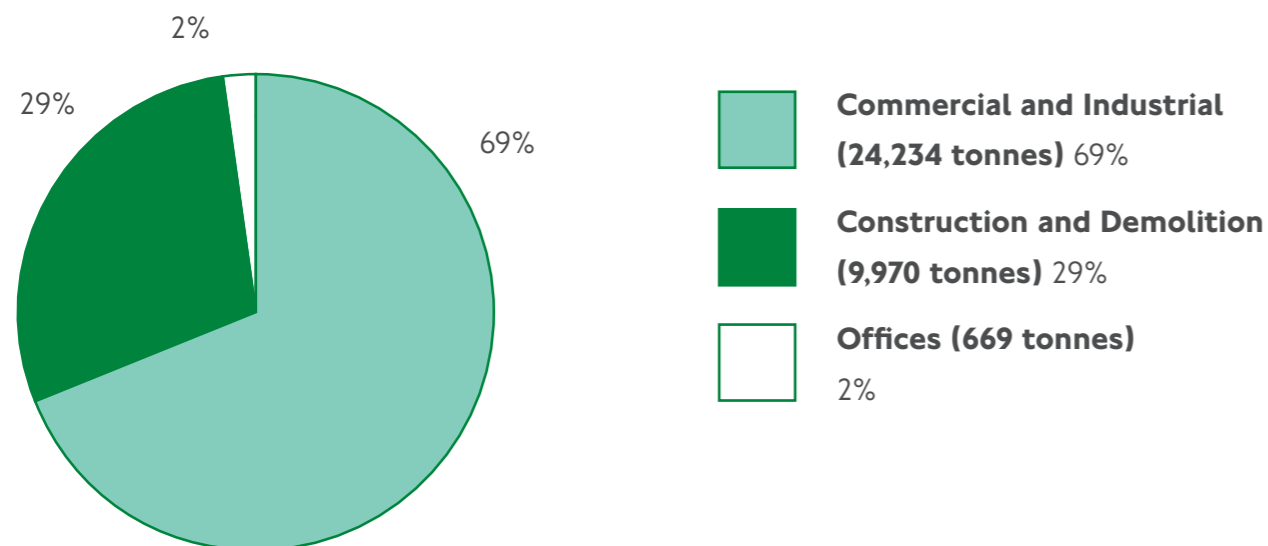
In 2008/2009 the following projects will be implemented to further raise the amount of recycling at LU:

- Waste generated at our head office buildings is managed by

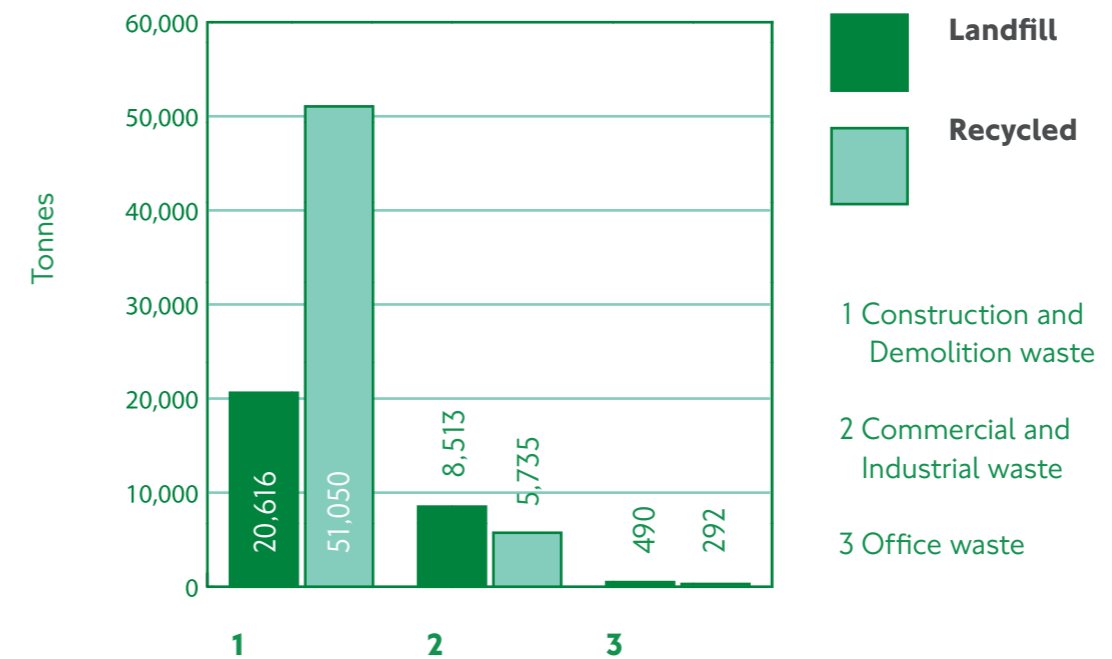
TfL's Group Property and Facilities division. This team has agreed a new 3-year waste management contract (to commence October 2008) which will set targets for office waste management

- Trial customer recycling bins on stations
- Introduce new monitoring systems for collecting construction and demolition waste data for non-PPP projects

Carbon emissions from Landfill waste



2007/2008 Waste destination

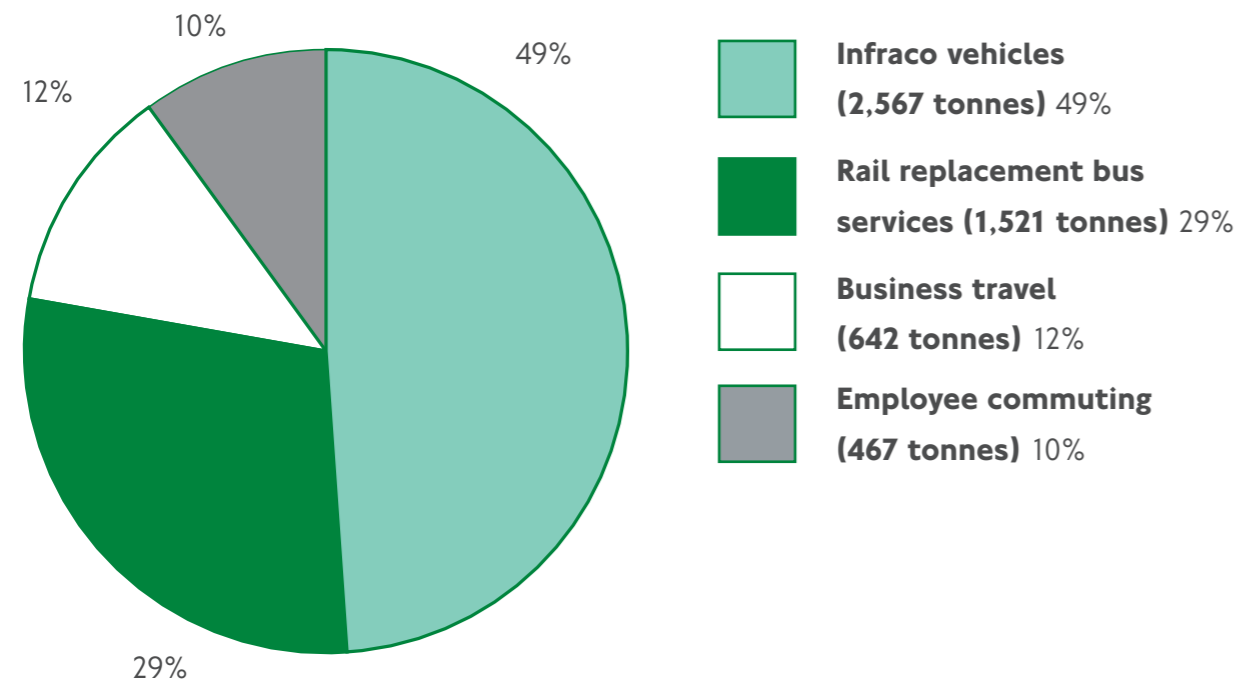


7.3 Transport related emissions

Total emissions: 5,303 tonnes CO₂e

Emission sources of indirect carbon emissions that arise from transport related activities at LU include; employee commuting and business travel, rail replacement bus services and infraco road vehicles.

Carbon emissions associated with transportation



7.4 Infraco road vehicles

2,567 tonnes CO₂e

The majority of the road support fleet used for LU activity is run by the Infracos and carbon emissions associated with fuel consumption accounted for as indirect emissions. The waste management fleet, supplied by Tube Lines, and vehicles used by the LU – British Transport Police (BTP) all contribute to the total carbon impact.

Infraco vehicles carbon emissions	
Emission source	Tonnes CO ₂ e
Petrol	401
Diesel	2,160
LPG	6
Total	2,561

7.5 Rail replacement bus services

1,521 tonnes CO₂e

Rail replacement bus services travelled a total distance of 1,200,000km in 2007/2008.

Rail replacement bus services provide alternative transport during planned closures to upgrade the Tube network. They produced additional carbon emissions on behalf of LU operations and are included within the carbon footprint.

The buses are owned and fuelled by third party organisations and therefore the carbon is classed as indirect – LU is not directly responsible for the fuel consumption and associated emissions.

Whilst the Tube is being transformed, the rail replacement bus services provide a vital role ensuring that passengers can keep moving. However, this must be balanced against the additional impact it is having upon the environment and air quality within London.

LU should consider the environmental impact when planning alternative transport measures. Having carried out successful trials, TfL have announced that all new buses entering service after 2012 will be hybrid powered. These vehicles reduce emissions of local pollutants and carbon dioxide by at least 30 per cent compared to conventional diesel buses.

From January 2004-2007, London took part in a project to reduce air pollution and noise by testing the first generation of zero-emission fuel cell buses. Ten new buses powered by hydrogen fuel will be launched in London between now and 2010, in a bid to reduce CO₂ emissions from transport and tackle climate change.



7.6 Business travel

718 tonnes CO₂e

Staff travelling for a business requirement covered over 1,300,000km in 2007/2008.

The LU organisation is spread across the capital. Travel between different operational areas and head office locations is frequently required and often essential to an individual's job. Generally staff members use public transport. Shared taxis are used by operational staff who start or finish work when no public transport is available.

It is not possible to assess the carbon impact of public transport journeys undertaken by members of staff during the working day. As in the case of employee commuting, Tube journeys are not considered as the total carbon emissions of the LU services have already been accounted for within this study.

In 2007/2008 it was not possible to calculate the carbon emissions of journeys to locations outside of London and data was only available for air travel. The LU Travel at Work policy implemented in January 2008

stipulates that air travel should be avoided within the UK and mainland Europe wherever appropriate. Not all business trips have feasible alternatives to air travel when time factors are taken into consideration.

The environmental impact of business travel could be reduced by:

- Finding alternatives to travel for meetings such as phone and video conferencing
- Use alternatives to air travel for all short haul distances in line with GLA policy

Taxi usage at LU has two categories; scheduled and special.

Scheduled taxis are employed by LU to run a timetabled route collecting members of staff who work on the operational railway. This is an essential service to enable them to get to and from work when other modes of public transport are not available. The second category, special taxis are those booked for individual journeys.

The LU Travel at Work policy requires special taxi usage to be fully justified and it is widely expected that the carbon emissions associated with this mode of transport will fall in the coming years. Early indications show that there has already been a dramatic decrease in special taxi usage since the policy's introduction.

The taxi company who provide the service for LU, use UK sourced biodiesel and operate a programme to measure and reduce their CO₂ emissions to zero with various global projects to offset their emissions.

Business travel carbon emissions	
Method of transport	Tonnes CO ₂ e
Air – Long Haul	299
Air – Short Haul	269
Scheduled Taxis	76
Air – Domestic	54
Black Taxis	20
Total	718

7.7 Employee commuting

497 tonnes CO₂e

The choices that staff make in how they travel to and from work indirectly releases carbon emissions that has been accounted for by LU.

To measure this impact, data was recorded by the LU Travel Plan Survey, commissioned for the Staff Travel Plan in 2007. The survey was implemented to determine travel choice rather than carbon emissions, but it has been possible to calculate the CO₂ impact of the main modes of transportation used.

Separate questionnaires were issued to operational staff and those based in head offices and the results highlighted a significant difference in travel habits. Although the Tube was the most popular mode of transport for all employees, some operational staff drive cars to their place of work, generally in remote locations. Due to the higher emission factors associated with car usage, this increased the carbon output.

The highest carbon emissions for head office staff came from national

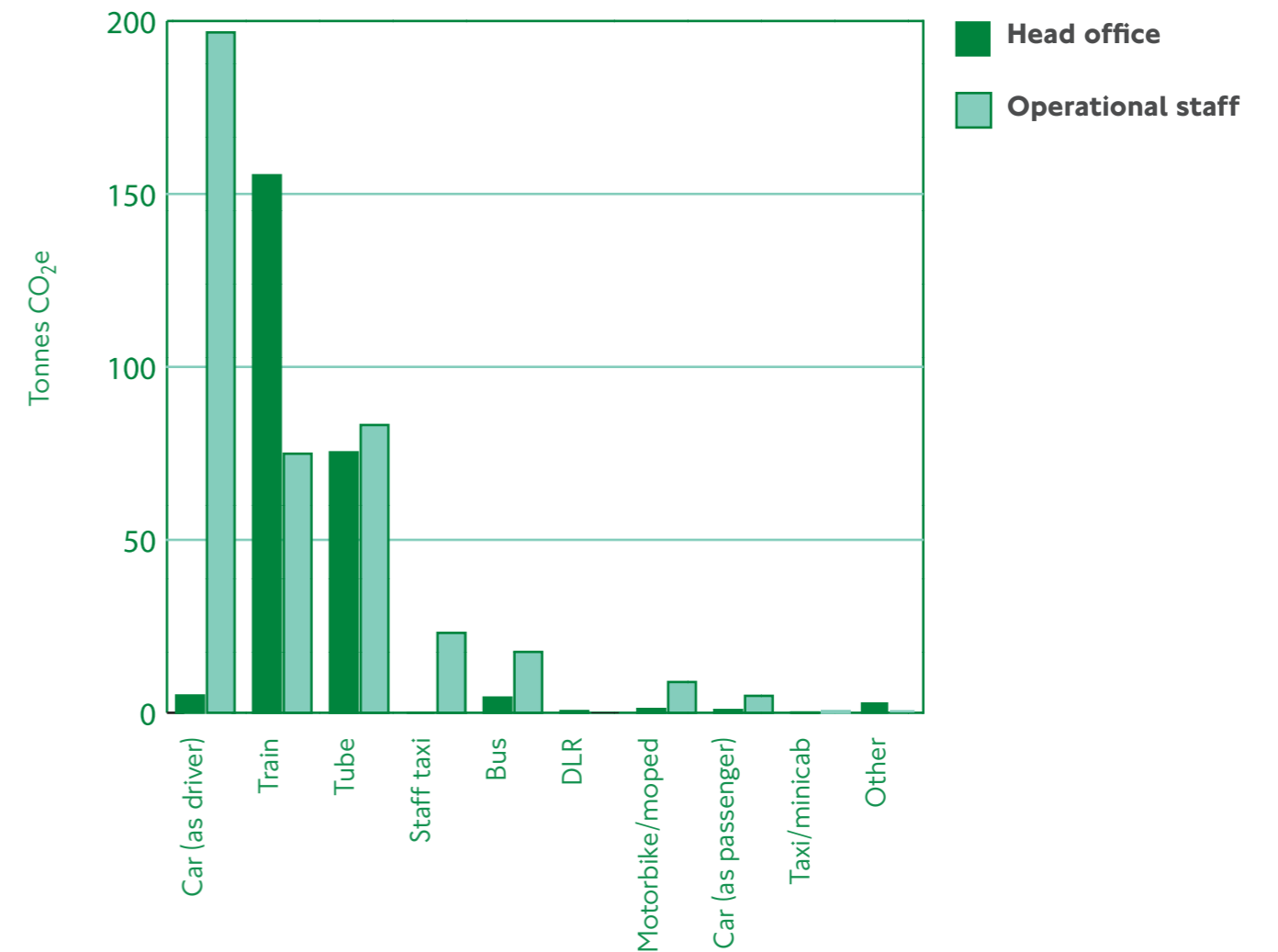
and suburban rail services. Using the rail network does impact upon the environment but nonetheless it is one of the least polluting modes of transport available.

The environmental impact of business travel could be reduced by:

- Encouraging staff to cycle to work. This will improve health levels as well as reduce the carbon impact of commuting practices. Members of staff would not need to cycle the entire distance to work but it would still be beneficial for short distances as part of the overall journey
- Sharing car journeys. This will dramatically reduce the carbon emissions associated with commuting whilst commuters still continue to benefit from the convenience of travelling by car.

LU runs a private car share scheme for staff and can match colleagues living near to each other and who share similar shift patterns.

Carbon emissions from employee commuting



7.8 Purchased materials and end use products¹¹

4,182 tonnes CO₂e

LU recognises the importance of moving beyond assessing the climate impact of core operations and towards a more comprehensive assessment of the GHG impact along the supply chain, in particular the materials purchased. As part of the broader climate change strategy, the organisation aims to reduce the carbon emissions associated with the life cycle of the products it purchases.

The scope of the current assessment encompassed only the materials sourced by LU for its head offices. It does not include materials sourced by infracos to maintain or upgrade LU's infrastructural assets. LU is currently working on a parallel initiative to incentivise infracos to use materials with less embedded carbon.

The objectives of the assessment were to:

- Broadly quantify the emissions associated with the production of the materials procured by LU: this will enable a comparison of the relative importance of these emissions compared to direct emissions from fuel use and indirect emissions from electricity consumption in LU's offices

- Identify the most important products with regards to their share of the total embedded carbon in purchases
- Identify the products for which less carbon-intensive alternatives exist; and assess the carbon savings LU could potentially achieve by switching to these alternatives
- Provide suggestions for how to improve the accuracy of the assessment and how to ensure 'green' procurement

Total embedded carbon emissions in purchased products for 2007/2008 are roughly 4,200 tonnes CO₂e. Most of these emissions result from the use of paper (about 70 per cent, 60 per cent of which is from 'Distributed paper' – in the form of posters, leaflets, maps etc that are provided for Tube passengers) and to a lesser extent from computer consumables.

These results suggest that the emissions associated with products purchased for LU offices (about 2,000 tonnes CO₂e, excluding the emissions associated with Distributed paper) are small, but not negligible, with regards to

LU's overall carbon footprint. In comparison, the electricity used to power LU's headquarters at 55 Broadway over one year is responsible for 1,628 tonnes CO₂e.

Below, are some options for reducing the carbon impact of the products used in LU's offices, and estimations of the potential carbon savings LU could achieve by implementing them:

- Using 100% recycled paper – 300 tonnes CO₂e per year saving
- Hot air dryers instead of recycled paper towels – 30 tonnes CO₂e per year saving

- When sourcing 80% recycled paper, it is important to ensure that the remaining 20% virgin pulp comes from Forest Sustainable Council-certified forests
- Investigate products with independent eco-labels (such as the European eco-label, which uses a flower logo) as they provide useful information to assess claims made by suppliers and distributors
- Suppliers should be asked to substantiate "carbon neutrality" claims within formation on the scope of the emissions offset and the type of carbon credits purchased (and whether it meets standards such as the Voluntary Carbon Standard, the Gold Standard or is a UN certified Carbon Emission Reduction credit)

LU materials carbon emissions	
Material	Tonnes CO ₂ e
Distributed paper	2,407
Computer consumables	849
Office paper	437
Office supplies	304
Food and drink	106
Carpet	74
Office furniture	4
Plastic cups	2
Total	4,182

¹¹ The Carbon Trust. (2008). *Embedded Carbon in LU Purchases*.

7.9 Water and wastewater

256 tonnes CO₂e

LU emits a total of 218 tonnes CO₂e through its water consumption. A total of 624 megalitres were consumed in 2007/2008 which is enough water to fill nearly 250 Olympic sized swimming pools.

LU Stations consumed the most water with a total share of 64 per cent of carbon emissions. Water is consumed in staff accommodation facilities, for cleaning purposes and public conveniences.

Depots also require a large amount of water for train washing facilities and the implementation of greywater recycling is being considered as part of the Depot Upgrade programme.

- Earl's Court
- Canning Town
- Wembley Park
- Westminster
- Golders Green
- Baker Street
- North Greenwich
- Rickmansworth
- Leicester Square
- Harrow & Wealdstone

LU water and wastewater	
Emission source	Tonnes CO ₂ e
Stations	140
Depots	63
Head Offices	15
Wastewater	38
Total	256

The carbon emissions associated with wastewater were calculated using the trade effluent and wastewater discharge quantities for the 2007/2008 period.

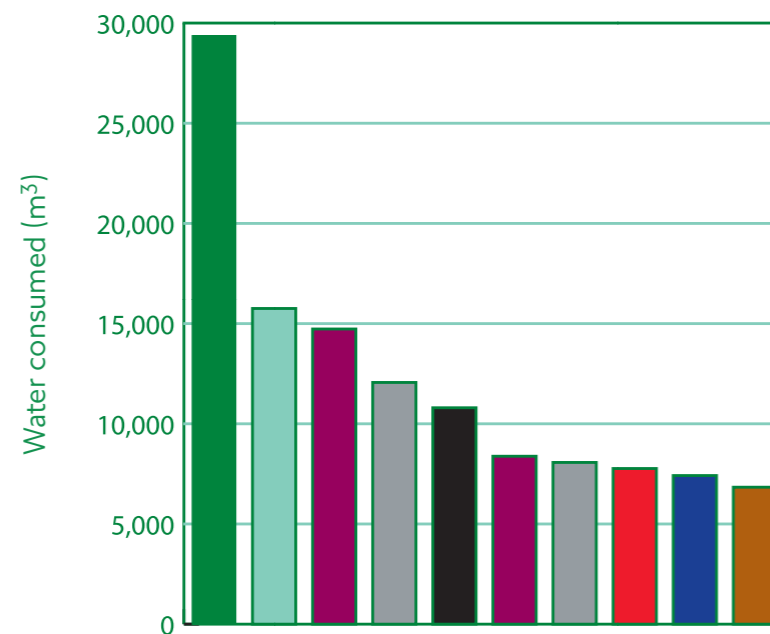
In total, 162 megalitres of wastewater was discharged and 70,794 kWh of electricity was consumed in the treatment process.

The carbon footprint report identified that Neasden depot consumed a far higher amount

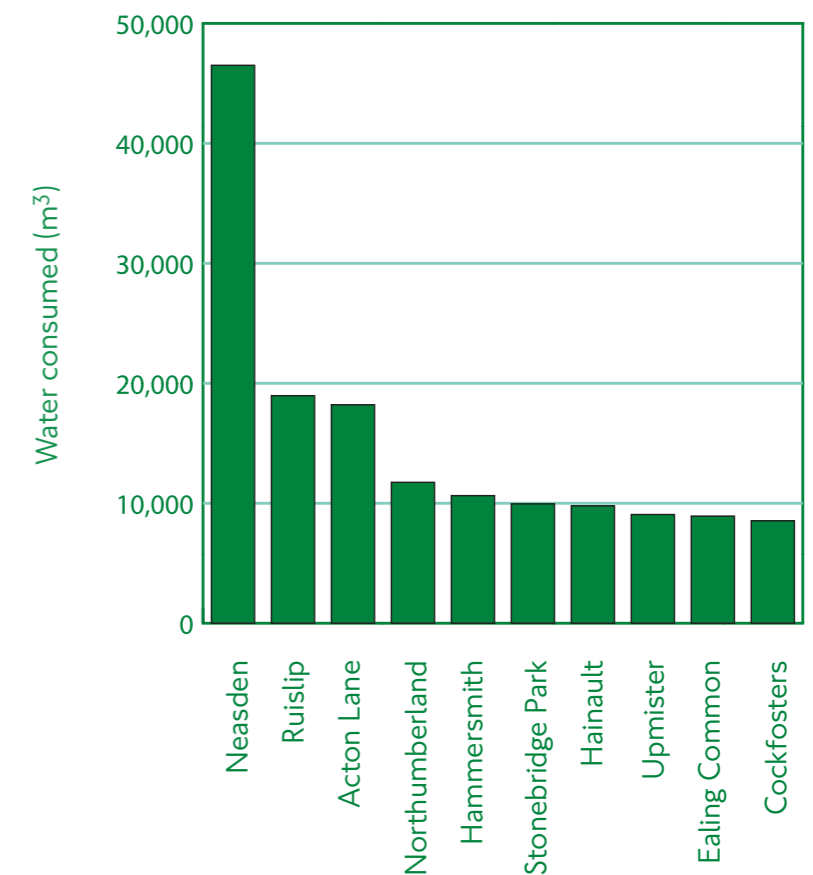
of water than any of the other depots and accounted for 22 per cent of all water used by the depots across the network. Following investigations, a water leak was discovered and this is now in the process of being remedied.

In collaboration with Thames Water, LU will undertake water audits at areas of high consumption to identify potential efficiencies that could be made.

Water consumption - top ten stations



Water consumption – top ten depots



8.1 A comprehensive carbon footprint

The 2007/2008 carbon footprint will assist the organisation to identify opportunities for improved environmental performance and energy efficiency, ensure compliance with tightening regulations and highlight cost savings by introducing a wider scope to the carbon emissions inventory.

LU's carbon footprint is sizeable, largely due to the amount of electricity required to run the operational railway. However, as identified in this report, the organisation is well prepared for future carbon reduction work and a number of projects that have the potential to dramatically reduce carbon emissions have/are being implemented across the organisation.

Application of the well regarded GHG Protocol methodology (see section 3) and inclusion of a wider range of emission causing activities, thereby defining an increased scope for the footprint has provided the following benefits:

1 It has assisted LU to prepare a GHG inventory that represents a true and fair account of the organisation's emissions.

2 The results from the 2007/2008 carbon footprint will be used as a 'baseline year' for the business so that emission reductions resulting from future carbon management projects can be calculated and verified. The results within this report may be revised when the Metronet carbon footprint for 2007/2008 has been fully calculated.

3 The data management tools established have simplified the production of a GHG inventory in the future and enabled LU to monitor and track carbon emissions throughout any given year and the organisation will ensure that the exercise is repeated annually.

4 The project has provided further information that can be used to build further strategies to manage and reduce GHG emissions.

5 The data management system and results from the footprint will provide accurate information that will facilitate participation in voluntary and mandatory GHG programmes (for example: the Carbon Reduction Commitment).

6 LU is keen to investigate the potential for applying for accreditation to national climate change action schemes such as the Carbon Trust Standard and the carbon footprint has enabled the organisation to collate the data required.

7 A wider range of emission causing activities has been incorporated to establish their carbon impact and set future reduction targets.

8 The carbon footprint will now allow carbon to be included as a key performance indicator as part of the strategic scorecard for the business. This report will identify key drivers and calculate theoretical maximum performance.

9 With a baseline year established, the organisation can now set targets for carbon emission reductions in accordance with the actions highlighted in LU's Carbon Emissions Reduction Plan.

The Greenhouse Gas Protocol Initiative

The Greenhouse Gas (GHG) Protocol Initiative is a multi-stakeholder partnership of businesses, non-governmental organisations (NGOs), governments, and others convened by the World Resources Institute (WRI), a US-based environmental Non-Governmental Organisation (NGO), and the World Business Council for Sustainable Development (WBCSD), a Geneva-based coalition of 170 international companies.

The methodology proposed for use within LU GHG accounting procedures is the commonly adopted GHG Protocol Corporate Accounting Standard. The first edition was published in September 2001 and enjoyed broad adoption and acceptance around the globe by businesses, NGOs and governments.

The GHG Protocol Corporate Standard provides standards and guidance for companies and other types of organisations preparing a GHG emissions inventory, more commonly known as a Carbon Footprint.



Inventory boundary

The first methodological requirement is to set the ‘organisational boundary’ for the inventory. This means determining which of LU’s business units will be part of the inventory.

LU’s organisational boundary can be established using one of three approaches. The three organisational boundary approaches are “equity share”, and two control approaches, “financial control” and “operational control”. London Underground’s organisational structure is reasonably complex, and joint operations such as the Private Public Partnership (PPP) contracts, affect the organisational boundary depending upon the approach chosen.

The operational control approach is the methodology that is most applicable to the business relationship between LU and the PPP suppliers Tube Lines and Metronet.

During 2007/2008, there was no shared equity between the organisations as both Tube Lines and Metronet were private companies. LU also had little

financial control over both organisations. However, in completing their obligations under the PPP Contract, both Infracos must follow procedures defined by London Underground. It is this ability to implement policies to ensure that the operation follows the organisation’s management procedures that leads to the Operational Control approach being selected for this process.

Ownership of Metronet passed to TfL in May 2008. For the 2008/2009 footprint the same approach is now being applied to the Metronet business and will be fully reported in 2008/2009.

To track performance, the ‘control’ approaches generally are more appropriate, since managers can be held accountable for only those activities that are under their control.



Defining LU's operational boundary means categorising the organisation's emission-causing activities.

The GHG Protocol describes two categories of greenhouse gas emissions, direct and indirect emissions, as well as the concept of 'scope'

Direct emissions – scope 1

These are emissions within LU's organisational boundary from sources that the business owns or controls.

For reporting purposes under the GHG Protocol methodology, direct emissions are termed "scope 1" emissions.

Indirect emissions – scope 2 and 3

Indirect emissions arise from LU's activities but are from sources owned or controlled by another organisation.

The most common example is electricity. For reporting purposes under the GHG Protocol methodology, indirect emissions are divided into the following two categories:

Scope 2: Emissions from electricity that is used by LU but is generated

by another company. In GHG Protocol terminology this is called 'purchased electricity'.

Scope 3: All other indirect emissions including water, waste and staff travel.



The emission causing activities that have been considered as part of LU's carbon footprint are listed below.

The impact of these activities has been measured in carbon terms to produce this report. Wherever possible, emissions of all greenhouse gases have been considered and the total carbon footprint is reported in CO₂ equivalents (CO₂e).

Direct (Scope 1)

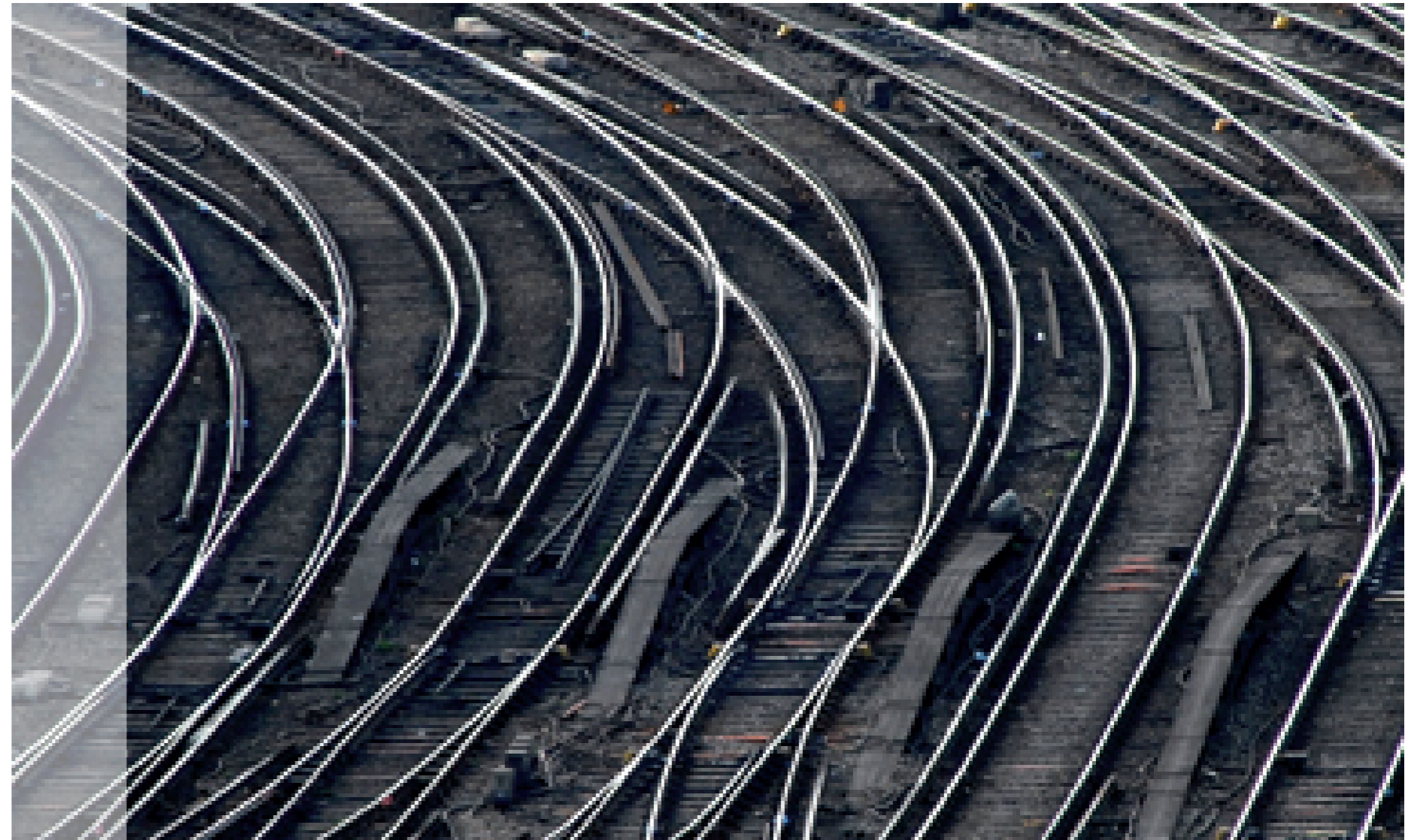
- Greenwich Power station gas and oil consumption
- Company leased vehicles (LU vehicle fleet)
- Gas consumption at stations, depots, offices

Indirect (Scope 2)

- Consumption of purchased electricity (traction and non-traction)

Indirect (Scope 3)

- Water consumption
- Wastewater production
- Waste production
- Employee business travel
- Employee commuting
- Rail replacement buses
- Joint partnership vehicles
- Third party production or manufacture of materials and resources used by LU (eg: paper, furniture, and equipment)
- Infraco activities
- End use products distributed by LU (eg: leaflets and marketing)



Emission factors are published by various entities such as local, state or national government agencies and intergovernmental organisations such as the Intergovernmental Panel on Climate Change (IPCC).

Emission factors are frequently updated and it is important to use the most up-to-date and relevant emission factors available.

The emission factors used in the 2007/2008 London Underground Carbon Footprint study are as follows:

- Electricity emission factors and figures for all other fuel types, unless otherwise stated, are based on those published by the UK Government's Department of Environment, Food and Rural Affairs (Defra) Annexes to Guidelines for Company Reporting on Greenhouse Gas Emissions: Updated June 2008
- Emission factors for water use are from associated guidance

produced by the London Climate Change Partnership and Thames Water available national average data for the energy required to treat and produce one cubic metre of clean water

- Waste water emission factors are based on available national average data for kWh of energy used in the treatment of waste water
- Methane emissions associated with the landfilling of waste are calculated using the IPCC Tier 1 methodology for the calculation of methane emissions from solid waste disposal sites
- Carbon emission data for materials purchased by LU is provided by the Carbon Trust and consultancy ICF International

