The future of work:

A cleaner, hybrid future

April 2023

IWG The Global Workspace Leader

In partnership with

ARUP

Introduction

Introductory note from Mark Dixon

As recently as December, scientists were highlighting the imminent risk that, even at the current 1°C level of global warming, at least five environmental 'tipping points' are likely to be passed – from the collapse of the Greenland and West Antarctic ice sheets to a massive die-off of tropical coral reefs.

According to Johan Rockstrom, co-chair of the Earth Commission and Director of the Potsdam Institute for Climate Impact Research, it looks set to get far worse. "The world is heading towards 2°C to 3°C of global warming," he says. "To maintain liveable conditions on Earth, protect people from rising extremes and enable stable society, we must do everything possible to prevent crossing tipping points. Every tenth of a degree counts."

Growth is clearly a priority for IWG, but we are determined only to expand as a carbon-neutral organisation. The action we have taken to restrict and offset IWG plc's environmental impact is having the desired effect; our strong rating by MSCI was upgraded to AA and I am very pleased to say that this month we have achieved carbon neutrality.

In my view, there is a glimmer of hope. As world leaders grapple with the biggest issue facing the planet, there are growing indications that the fast-changing working habits of millions of people across the world mean the days could be numbered for one of the greatest drivers of global emissions: the daily commute.

Little has done more over the years to depress, stress and irritate workers than the daily commute, affecting people in otherwise fantastic careers, in exceptional cities and with great employers. It distances families, dilutes communities, contaminates the environment and wastes vast amounts of time and money.

For many, today the daily commute is entirely unnecessary, because the office is no longer a physical place that people have to go to every day. Today, two thirds of workers in the USA can operate remotely. And 84% of UK workers who worked remotely during the pandemic said they planned to continue using hybrid working. Rather, it has evolved as a space where people meet and collaborate when needed, whilst the cloud has grown as a digital office where data is saved and is accessible at any time, from anywhere.

While sophisticated web-based technology has been around for a few years, it has only been since the pandemic when companies have seen first-hand that not only does hybrid work, but they are able to thrive under the model. Firms are able to operate more efficiently with a more productive workforce, while employees are happier as they see hybrid working as the equivalent of a 7% to 8% pay rise.

This rapidly growing demand for hybrid working is propelling the IWG business forward as we seek to open up to 1,000 new locations over the next year. The demand to work locally is particularly strong in the suburbs, former dormitory towns, satellite villages and countryside communities that used to be denuded of their people in the working week by the irresistible draw of the big city. In parallel, many businesses are now typically opting for a fraction of their former conventional city centre space in favour of sites closer to where their employees live and actually want to be.

Just look at the sites of some of our most recent openings. In the UK, take Gerrards Cross, Buckinghamshire (population 8,000); Marlow, also in Buckinghamshire (14,000); and Chippenham in Wiltshire (relatively large at 45,000). In the USA: Kodak, Tennessee (10,500); Destin, Florida (14,000); Bluffton, South Carolina (27,700); Middleton, Wisconsin (20,000); Ridgeland, Mississippi (24,000); and Stafford, Virginia (5,500).

That is not to say that businesses are abandoning city centres: far from it. Increasingly, we are helping companies shake off the expense of the long-term lease and replace it with a flexible, cost-effective agreement on a smaller space in one of our city-based centres. This, too, is a trend that is proving highly beneficial for IWG and as a result we will continue to expand across metropolitan, suburban and rural locations. Make no mistake: the office is most definitely not dead; it has just changed location!

Hybrid working also gives businesses the flexibility to scale up or down quickly without being locked into lengthy contracts. It is also 'a no brainer' when it comes to profit, with an independent Global Workplace Analytics survey recently showing that hybrid working can save organisations an average of more than £9,000 per employee per year.

I'm delighted that we have partnered with Arup to conduct a first of its kind research and analysis needed to quantify the hybrid model's true potential as a means of reducing work-related carbon emissions.

We wanted to answer this question: "What is the environmental impact, in terms of carbon emissions, of a hybrid working model with office workers reducing their commute to their city centre office and working more from home or a local workspace?"

The project's findings are in this report – and they hint at the immense power that's now in our grasp to radically reduce humanity's negative environmental impact. The headline result is that allowing people to work close to home, enabling them to split their time between home and a local workplace, has the potential to reduce a worker's work-related carbon emissions by over half - and as much as 70% in Los Angeles.

Anything that's capable of such dramatic positive change must be taken very seriously indeed.

The findings of this research are very clear. Five-day commuting to city centre offices have the largest carbon footprint. Simply spending less time in or travelling to a city centre drives a drop in emissions from buildings and vehicles alike. The higher a city's car usage, the greater will be the immediate positive impact of the shift to home-based and local working.

Shifting long-held patterns of behaviour takes time. In order to prompt a change in mind-set, governments and local authorities must continue to develop policies that help companies to expand hybrid working and invest in the required relevant infrastructure to support them.

We need to create integrated approaches that leverage better, more sustainable transport networks. We must have more joined-up thinking when it comes to transport planning and land usage, the development of safe cycling networks, better public transport connectivity, faster adoption of electric vehicles, the accelerated production of renewable energy, retrofits of existing premises and better energy-performance for new buildings.

So I have a request to make of governments, businesses and public policy-setting bodies everywhere.

Consider the implications of these findings for the future of urban areas and working patterns. Develop policies that empower individuals and businesses to make a positive difference every day. And work together to create and deliver integrated strategies with hybrid working at their heart to reduce work-related carbon emissions in cities right across the world.

The results of our research with Arup show clearly that, given the right will, this is within our power – right now.

The single biggest change we can all make right now is to provide people with the choice to work closer to where they need to be, and with lower impact on the environment. And that's down to all of us.

Mark Dixon, Founder and CEO, IWG plc

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Introduction

Do our new ways of working have a lower carbon footprint than the traditional commute into the central city?

We are living through a historic change in our patterns of working.

The widespread adoption of hybrid working has accelerated changes in our society, creating new possibilities for the future and raising new questions about what tomorrow will bring. Where jobs could be performed remotely, companies have pivoted rapidly to allow for remote working, underpinned by remote collaboration technologies. This has broad-ranging implications, not least the relationship between hybrid working and the climate crisis.

The frequency or ability to remote work varies by type of work and also by an individual's personal characteristics.

These include whether a worker needs to be physically present on-site to carry out their duties, work with others or use fixed-location machinery or equipment, and the influences extend to out-of-work commitments, such as caring responsibilities.

McKinsey Global Institute estimates that nearly half of UK workers could be effective with a hybrid working arrangement. Around 26% of UK workers could effectively work remotely for 3-5-days, and 22% more could remain effective whilst working at home for 1-2 days a week (McKinsey Global Institute 2021, 120). In the US, the number is about 40% (McKinsey Global Institute 2021, 122). Some sectors, such as construction, accommodation, agriculture and food service, could complete only 20% of their work remotely, but other sectors such as finance, management, and IT could work remotely on a majority of their tasks (McKinsey Global Institute 2021, 40). Overall, the analysis shows that the potential for remote work is more common for skilled and educated workers and in advanced economies.

As the Covid-19 pandemic subsided, governments reduced or eliminated restrictions and guidance on workforce movement. The fully remote working patterns for many employees seen during the pandemic gave way to a hybrid working model which has been widely embraced. Variations of this model either encourage or mandate employees to split their time working in their city centre office and working from home or from local coworking spaces. Hybrid working is expected to remain the norm in the post-pandemic world – at least for highly skilled workers in industries and occupations that accommodate the model.

Our research question examines one aspect of the relationship between hybrid working and the climate crisis.

The impacts of this shift towards hybrid working on society, the economy and the environment are manifold and still evolving. The focus of this commission was to interrogate the environmental (carbon) impacts. The core question was:

What is the environmental impact, in terms of carbon emissions, of a hybrid working model with office workers reducing their commute to their city centre office and working more from home or a local workspace?

Introduction

Our study considers the transport and buildings emissions associated with hybrid working.

We sought to answer the question of how new working patterns are affecting carbon dioxide (CO2) emissions.

The report calculates CO2 emissions arising from both commuting and energy use in workspaces. The focus of the study is office-based employees who work in central business districts, so it does not consider the carbon emissions for changes in work patterns for other types of employees. It also does not include other types of emissions such as embodied carbon or other travel-related emissions such as business travel or travel during the workday itself.

The report assesses different future patterns of working and combines the findings of Arup's Transport Carbon Analysis Tool (T-CAT), which quantifies the CO2 emissions related to transport, with an analysis of energy use and CO2 emissions from different types of workspaces.

The analysis focused on two cities: Los Angeles and London. We also assessed the transport-related emissions in four additional cities: New York City, Atlanta, Glasgow and Manchester.

The emissions are calculated on a per person basis. Therefore, it does not reflect the emissions caused as a consequence of a person's working location. For example, working from home may lead to fewer people in the office and higher emissions per person.

Structure of the report

The remainder of the introduction provides definitions of important terms and gives an overview on the state of transport and building emissions in the US and UK.

Then, we report the findings of our analysis for Los Angeles and London. For these two cities, the analysis combines the transport and buildings emissions into an overall assessment of the carbon emissions of different ways of working.

The following two sections give more detail on the findings of the transport and buildings analyses. The transport analysis section reports the findings for all six cities, and the section on the buildings analysis reports more detail for Los Angeles and London.

The conclusions section summarises the key findings and offers some preliminary thoughts on what this may mean for the future.

The appendix details the methodologies of the transport and building analyses.

Introduction

Definitions

Remote working
Working from a location other than a company's main office.

Hybrid working
A working pattern which includes working from a company's city centre office some of the time and remote working – including from home and from a local workspace – some of the time.

Office attendance
The proportion of employees in the office as a share of the total workforce based in an office.

Office utilisation
The rate at which the office is used when compared to its total capacity. This is also sometimes called office occupancy.

Carbon footprint
A measure reflecting the carbon emissions impacts attributable to the actions of a specific individual or organisation.

CO2e (Carbon dioxide equivalent)
A measure used to compare the emissions of different greenhouse gases in a consistent way. The emissions are reported based on their Global Warming Potential which is identified by converting amounts of other gases to the equivalent amount of carbon dioxide with the same global warming potential.

Emission factors
The equivalent carbon emissions emitted by a specified fuel source per kWh.

'Work-based' emissions
The emissions solely generated by transport and building use. It does not include other work related emissions such as business travel, lunch or embodied carbon for construction of offices. For transport, this is the emissions from the journey to and from the workspace using the primary transport mode (i.e. the mode which covers the longest distance). For buildings, this includes all emissions from an office building and only the extra emissions in a home that are attributable to home working (for example, energy use to power the refrigerator is not included in work-based emissions).

Operational carbon (considered in our study)
The carbon emissions generated from the operational phase of the activity. The carbon emissions reported in this study are solely based on operational carbon.

Embodied carbon (not considered in our study)
The total emissions generated to produce a built asset such as a car or building. This includes emissions from extraction, manufacture/processing, transportation and assembly of every product and element in an asset.

Mode split
The percentage of people using a particular transport mode compared to the ratio of all trips made.

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We analysed both the transport and building emissions for two cities – Los Angeles and London. We analysed the transport-related emissions in four additional cities – New York City, Atlanta, Manchester and Glasgow.

Introduction

Transport emissions are the largest source of emissions in both the US and UK.

Transport emissions in the UK

While many sectors of emissions – including business and energy supply – have had consistent decreases over time, emissions from transport have remained stagnant, with only a 5% decrease between 1990 and 2019. In 2020, 25% of carbon emissions came from the transport sector, the most of any sector.

Private vehicles are the largest single contributor within transport. Indeed, while much of London benefits from excellent public transport and only about one in three people drive to work, nationwide, that figure is approximately two in three.

The UK has committed to achieving Net Zero by 2050, which includes increasing the percentage of trips taken by sustainable modes, such as walking, cycling, and public transport.

This policy backdrop informed our study. We selected a spread of UK cities to reflect different transport option availability and commuting patterns. Additionally, we used a model year of 2025 to reflect some of the short-term progress towards Net Zero.

Source: Department for Business, Energy & Industrial Strategy 2021a

Transport emissions in the US

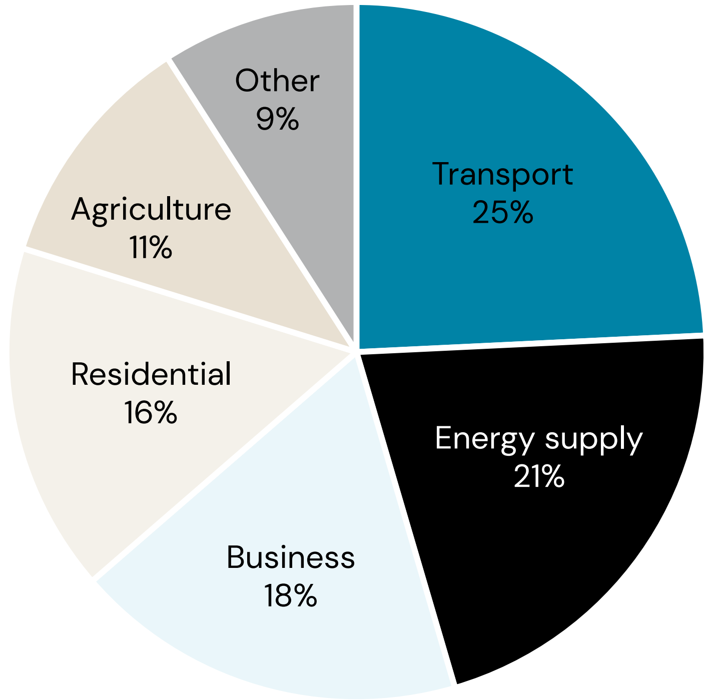
In the US, emissions distributions are similar. As in the UK, the largest sources within the transport sector are personal vehicles, which contribute over half of all emissions. However, per capita transport emissions in the US are more than 2.5 times higher than the UK.

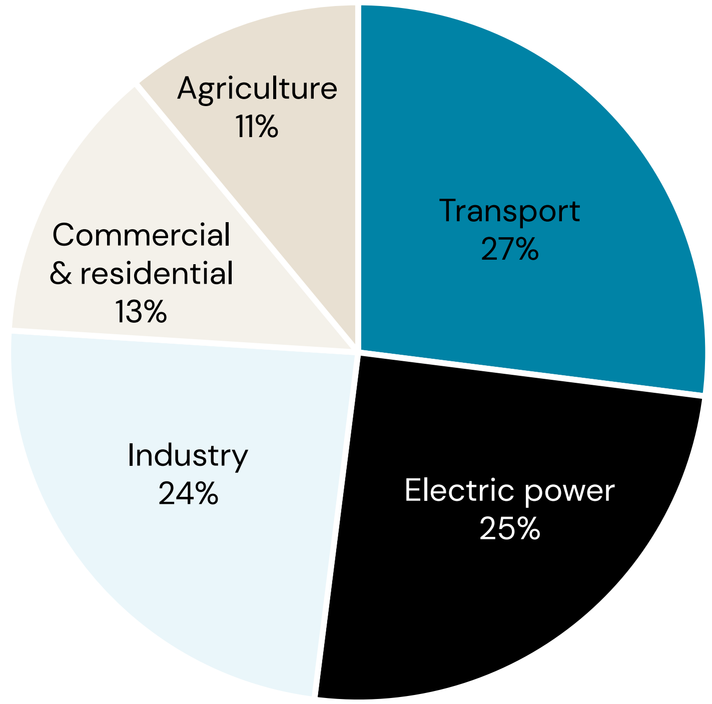
Transport emissions remain high due to a number of factors. These include: a 30% increase in vehicle miles travelled, increases in demand for larger, less fuel efficient vehicles and low public transport use in all but a handful of cities.

Planning is not as nationally centralised in the US as in the UK, but some efforts to switch to more efficient fuels, increase fuel efficiency and reduce travel demand are beginning to influence emissions figures.

Again, this backdrop informed our study. In particular, New York City benefits from high public transport use, while Atlanta and Los Angeles have lower public transport use. Examining all three provided good variety for the modelled scenarios.

Source: American Public Transportation Association 2020





Emissions by Sector in 2020, UK (top) and US (bottom)
Source: US Environmental Protection Agency (2022); UK Department for Business, Energy & Industrial Strategy. (2020)

Introduction

In both the US and UK, office buildings are a major consumer of electricity and gas.

Buildings emissions in the UK

Of the 28 million homes in the UK, approximately 90% currently use fossil fuels. The predominant use is for space heating, but also for cooking and hot water (BEIS 2022a).

There is substantial variation between buildings and homes in the UK, from the type of ownership, to their design, location and use. Therefore, emissions need to be adapted for the varied heat/energy sources and construction materials used for the buildings.

Offices make up 20% of the UK non-domestic building stock and are among the largest consumers of gas and electricity as a proportion of total building consumption (BEIS 2022b). Schemes such as NABERS and the Real Estate Environmental Benchmark (REEB) help to support design for performance to ensure emissions are accurately modelled (BEIS 2021b).

The UK has committed to achieving Net Zero by 2050 (BEIS 2021a). To support this target, the UK Government is focusing on improving performance of new and existing buildings (Department for Levelling Up, Housing and Communities 2021).

Buildings emissions in the US

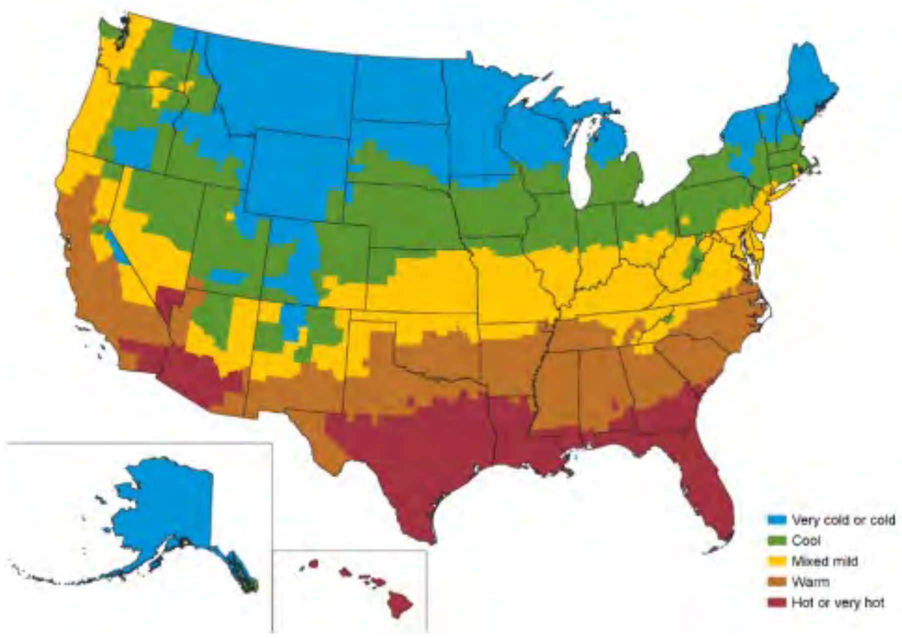
The US has committed to halve its carbon emissions by 2030, while California has set out a Climate Action plan to be net-zero carbon by 2045 (The White House 2021; Office of Planning and Research 2022).

The US spans a range of climate zones which impact the equipment choices, energy sources and architectural styles of properties. California is in a warm climate and, therefore, has lower dependence on natural gas.

Households in the US account for 55% of the energy used in buildings. However, household energy consumption in Los Angeles is 31% less than the average US household, highlighting the more favourable climate. (United Stated Energy Information Administration 2018a)

Offices in the US consume the most overall electricity out of all non-domestic buildings. Office electricity consumption is three times greater than their natural gas consumption, reflecting a greater reliance on cooling, particularly in the South. (United Stated Energy Information Administration 2018b)

California has launched programmes to promote building electrification, which supports the switch from fossil fuels to efficient electric heating and cooling (CA ARB, 2022).



Climate Zones in the US
Source: United Stated Energy Information Administration 2018a, 18

The carbon savings of hybrid working in Los Angeles and London

The carbon savings of hybrid working in Los Angeles and London

Our carbon analysis considers emissions from transport and buildings in two cities: Los Angeles and London.

To understand the carbon footprint of new working patterns, we analysed the transport and buildings emissions related to hybrid working in two cities: Los Angeles and London.

Los Angeles

The city of Los Angeles covers a geographical area of 1,299 km² and is home to 3.8 million residents (United States Census Bureau 2021). Approximately 66.5% of the city's working-age population is economically active.

The McKinsey Global Institute estimates that 39% of the US workforce could work remotely for at least 1 day per week, and this figure will be much higher in Los Angeles due to the concentration of industries that permit remote working (McKinsey Global Institute, 41). The American Community Survey found that 23.8% of working residents aged 16 or over in Los Angeles selected 'work from home' when asked about their mode of travel to work, exceeding the national work-from-home average of 17.9% (United States Census American Community Survey 2021).

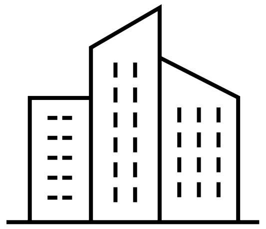
London

With a population of 9.8 million people and a geographical area of 1,572 km2, London is the UK's largest and most populous city. Among its large pool of working-age residents, 72.1% are economically active. (NOMIS Official Census and Labour Market Statistics 2021). In 2021, 36% of all employees in London – 1.9 million people – worked in office-based industries (Office for National Statistics 2022).

As a result, London has the highest proportion of hybrid workers in the country, with 57.5% of London's workforce reporting both travelling to work and working from home in a given work week. This is compared to the UK average of 42.7% (Office for National Statistics 2022).

The carbon savings of hybrid working in Los Angeles and London

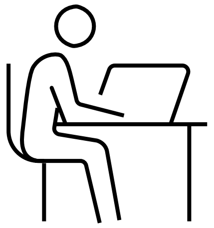
We compare three types of workspaces. We have made the following key assumptions to inform our analysis.



City centre workspace

We assume that the city centre workspace is located in the central business district. These locations typically benefit from excellent public transport accessibility. In London, we base our findings on the travel patterns of commuting trips to the City of Westminster and the City of London. In Los Angeles, we use Downtown Los Angeles.

For the building-related emissions, we use industry-standard measured energy benchmarks for offices in the region. This considers all energy usage relating to office consumption, including small power, lighting, heating, air-conditioning, ventilation, and hot water. The benchmarks provide data on a floorspace basis (CO2 emissions per sqm or sqft), so we convert this to a per-employee basis using the average floorspace per employee in an office building. Typical office utilisation rates fluctuate due to inefficiencies, employees being on holiday or working from home. The emissions per employee are based on typical office utilisation rates of 65%.



Local workspace

A local workspace could be a coworking space, a satellite office, or even a café or library. We have assumed that the local workspace is not in the city centre and is within 6km – a 15 to 20-minute cycle – of a worker's home. The profile of the local workspace in our analysis is based on the characteristics of a typical IWG office which were provided by IWG.

To calculate transport-based emissions, we first need to know the modes that workers will use to travel to their local workspace. We used data on existing commute trips to estimate the typical mode split of shorter distance journeys to work.

For the building-related emissions, we again use industry-standard measured energy benchmarks for offices in each region because IWG's portfolio performs similarly to other offices. As with city centre workspaces, we convert these to a per-employee basis. We uplift the emissions based on a utilisation rate of 80% which IWG have provided. IWG's business model means that their offices are better utilised than a traditional office, so emissions per employee are lower.

Home

For a workspace in one's home, we assume that there will be no transport-related emissions, as people would not be making any trips to 'travel to work'.

In calculating emissions related to the building, we use a bottom-up calculation by adding up the energy used by different sources which supports working from home. These include power for laptops, screens and home appliances, power for lighting, power for space heating, domestic hot water and space cooling. We do not consider energy that would be used even if the building was not being used as a workspace, for example the fridge/freezer.

The carbon savings of hybrid working in Los Angeles and London

Our analysis compares four scenarios which vary the attendance rates across the three workplace types.

1. **Traditional 5-day commuting** – The employee attends their office in the city centre all year round, reflecting the typical pre-pandemic working patterns.
2. **Home and headquarters** – The employee splits their time 50:50 between a office in the city centre and home. Transport emissions are zero while at home. However, the emissions from the employee's home will increase to allow for increased heating, cooling and equipment usage.
3. **Close to home** – The employee splits their time between home and a local workspace, altering their commuting patterns. Because their local coworking space has a higher occupancy rate than their office in the city centre, building emissions are lower than if they were working downtown.
4. **HQ, local workspace and home** – The employee divides their time between all three work locations, attending the local workspace and home far more frequently than the city centre office, which they only use on 10% of their working days.

	City-centre workspace	Local workspace	Home
Traditional 5-day commuting	100%	0%	0%
Home and headquarters	50%	0%	50%
Close to home	0%	50%	50%
HQ, local workspace and home	10%	50%	40%

The carbon savings of hybrid working in Los Angeles and London

In addition to these four scenarios, our analysis also includes a more environmentally-friendly 'variation' of the local workspace.

This variation applies to two scenarios – close to home and HQ, local workspace and home. In these 'improved' variations, we assume lower transport- and building-related emissions.

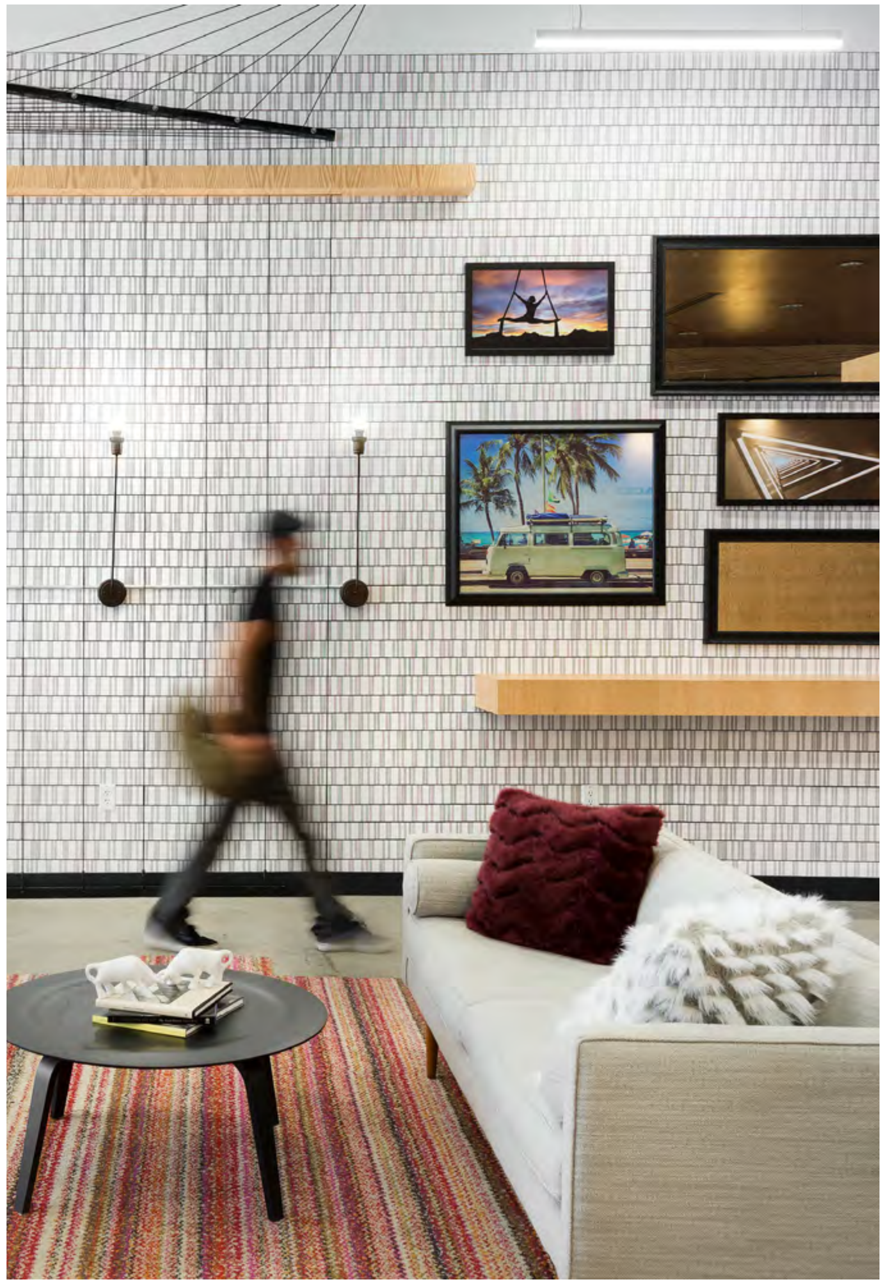
For transport-related emissions, the 'improved variation' has a more sustainable transportation mode split, reducing the amount of people driving to a local workspace and increasing the number of people using sustainable modes like walking, cycling and public transport.

For building-related emissions, the 'improved' variation assumes that the local workspace buildings perform better than the standard office stock in terms of carbon emissions, whereas the four base scenarios assume the average emissions from a standard office building.

- For local workspaces in Los Angeles, we calculate the overall emissions for the 75th percentile of energy performance for office buildings in California based on data collected in the Commercial Buildings Energy Consumption Survey.
- For local workspaces in London, we use the emissions for offices that are on the path to reach NetZero as defined by the UK Green Buildings Council. This represents the top 10-20% of the current office stock. For both cities, the 'improved variation' assumes local workspaces do not use gas as part of their energy mix.

We have included these variations on the basis that the adoption of more environmentally friendly modes of transport, including walking and cycling, will accelerate, along with demand for more sustainable buildings and workspaces.

The 'improved' variation does not reflect the current mode split or the current building portfolio. IWG should continually review the environmental footprint of its buildings and further changes in buildings and travel behaviour are required to meet these ambitious targets. These interventions would support IWG's sustainability vision to "act in a socially and environmentally responsible way" (IWG 2023).



The carbon savings of hybrid working in Los Angeles and London

To achieve the environmentally-friendly 'variation', action is needed to tackle both transport and buildings-related emissions.

Transport emissions

IWG can support reductions in transport emissions through a range of measures, such as:

- Creating a dense network of local workspaces across the country, reducing the distances to travel and minimising the drawbacks to using public transport, cycling or walking.
- Providing high quality facilities such as cycle parking, showers and changing rooms.
- Working with local authorities to ensure that employees have safe and coherent routes to cycle and walk to the workspace.
- Reducing the amount of car parking provided at their locations and continuing to roll out electric vehicle charging points where feasible.
- Providing a pool of cycles for borrowing.
- Choosing sites for future local workspaces in areas with good public transport connectivity and high walkability, and areas where local workspaces are scarce, such as commuter or rural towns.

Building emissions

Further reduction in building emissions can be unlocked by further increasing the number of best-in-class buildings leased. IWG has potential to achieve this through continually seeking buildings with green certification, high energy performance and other sustainable features, as set out in the investment strategy.

For buildings already in their portfolio, IWG can invest to improve their building performance through measures such as:

- Improving the thermal fabric of the building by retrofitting rather than building new.
- Occupying all electric buildings where possible, by utilising heat pumps for heating and cooling.
- Assessing the current comfort criteria and tuning the building maintenance system.
- Metering data at half hourly intervals and disclosing information via standard reporting methods.

This study has only focused on operational carbon; however, embodied carbon must be considered when implementing any interventions. This could be achieved through examining commonly purchased items, especially within fit-out.

The carbon savings of hybrid working in Los Angeles and London

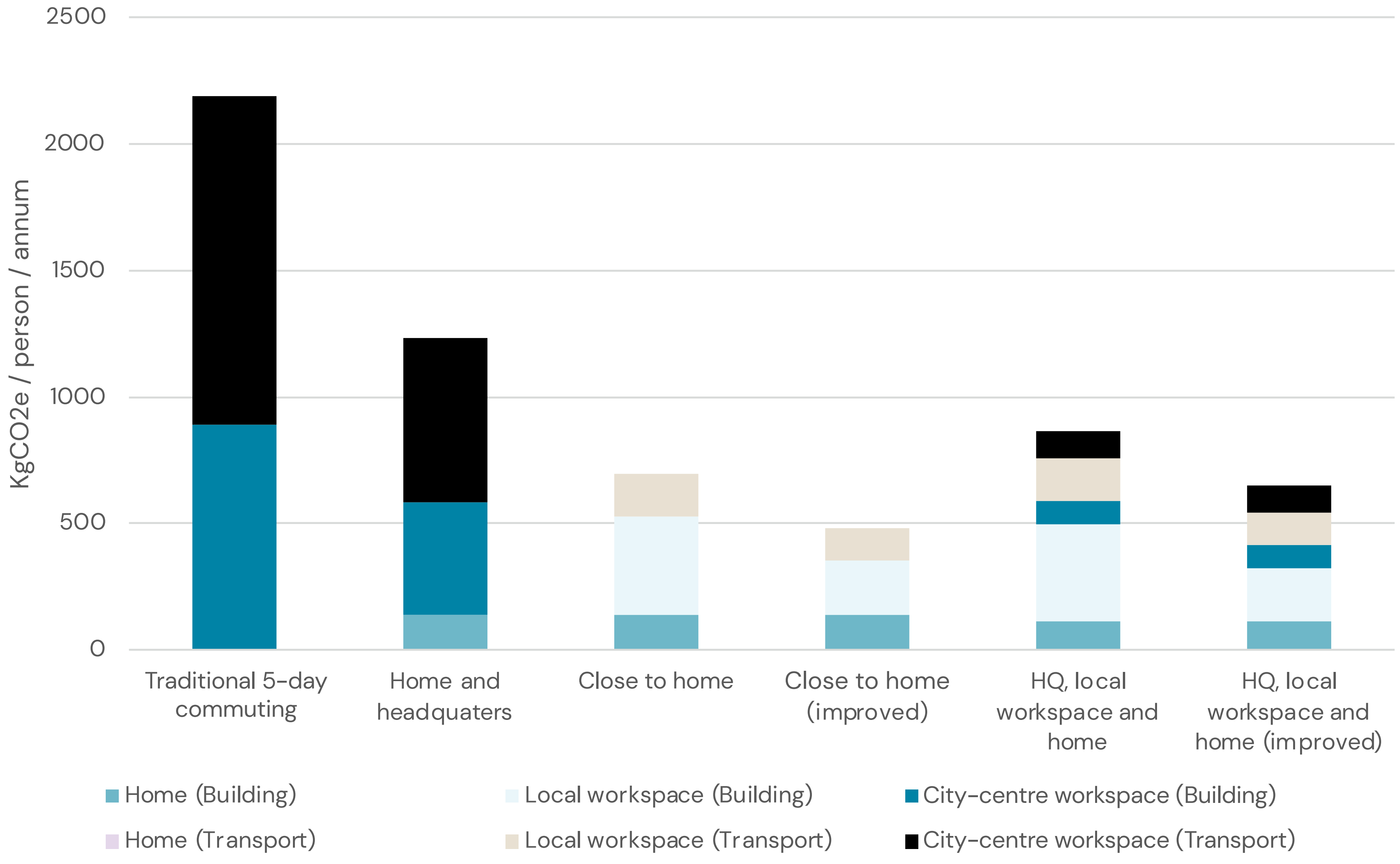
In Los Angeles, traditional 5-day commuting has the highest carbon emissions, of which the majority of emissions come from transport rather than from buildings.

Because the car is such a large contributor to emissions in Los Angeles, there is much greater variation across scenarios than shown in London. The scenarios which reduce the amount of driving have the lowest carbon emissions. If a worker in Los Angeles stopped traditional 5-day commuting into the city centre and instead worked close to home, their carbon footprint would drop by approximately 70%.

The close-to-home scenario has the lowest emissions of the standard scenarios because of the large reduction in transport-related emissions compared to travelling to a city-centre workspace.

Compared to London, the scenarios for Los Angeles have a larger proportion of transport-related emissions relative to building-related emissions. Also, in all four scenarios, Los Angeles has significantly higher emissions per person than in London. The carbon emissions of the best performing scenario – close to home – is roughly equal to the worst performing scenario in London. Likewise, the worst performing scenario for Los Angeles – traditional 5-day commuting – has triple the emissions of the same scenario for London.

The two improved scenarios have the lowest emissions. These scenarios require both behavioural change and physical interventions which are necessary to transition towards NetZero.



Los Angeles' transport and building related emissions for each scenario
Source: Arup analysis

The carbon savings of hybrid working in Los Angeles and London

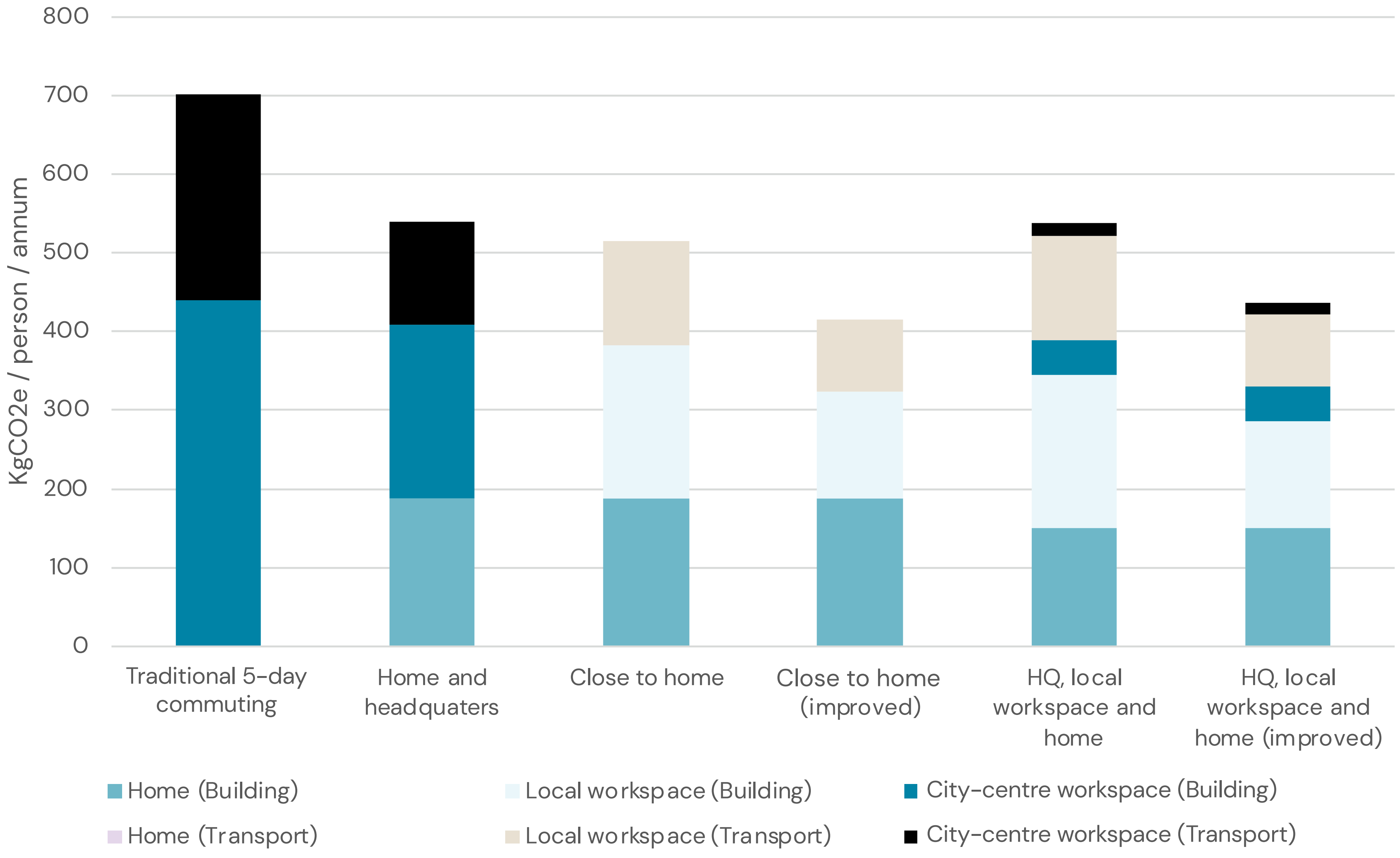
In London, like in Los Angeles, traditional 5-day commuting is the working pattern with the highest carbon emissions. Unlike Los Angeles, more emissions come from buildings than from transport.

In all four scenarios, emissions from buildings contribute the majority of emissions because London has a high share of people who walk, cycle or take public transport.

Traditional 5-day commuting is the most carbon-intensive of all four scenarios, indicating scenarios which reduce the number of trips to the city centre will reduce the carbon footprint of working. Transport makes up around 37% of total emissions when working from a city-centre workspace.

Emissions from buildings are relatively similar across all four scenarios, so it is the change in transportation that is driving the difference across all four scenarios. Therefore, the three scenarios which reduce travel to the city centre show much lower transport-related emissions.

The close-to-home scenario has the least associated carbon emissions because a reduction in building emissions offsets a small increase in transport emissions. This small increase is due to a modelled increase in car use to access local workspaces. Continued investment in sustainable travel infrastructure and a continued proliferation in local workspaces is likely to cause commuters to use cars less frequently, thereby reducing transport emissions from trips to local workspaces.



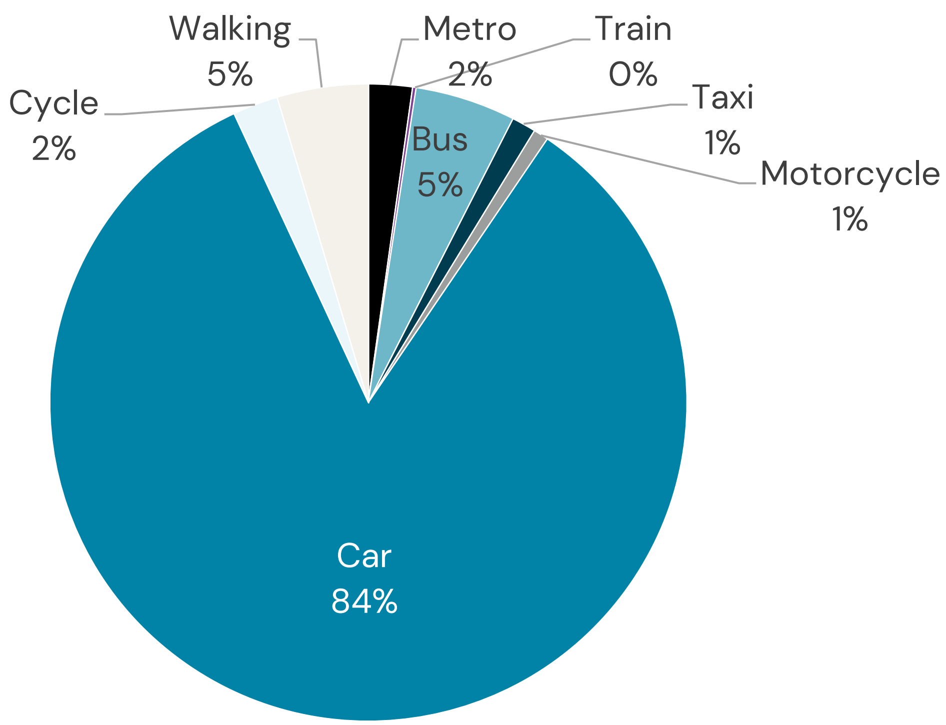
London's transport and building related emissions for each scenario
Source: Arup analysis

Detailed findings of the transport carbon analysis

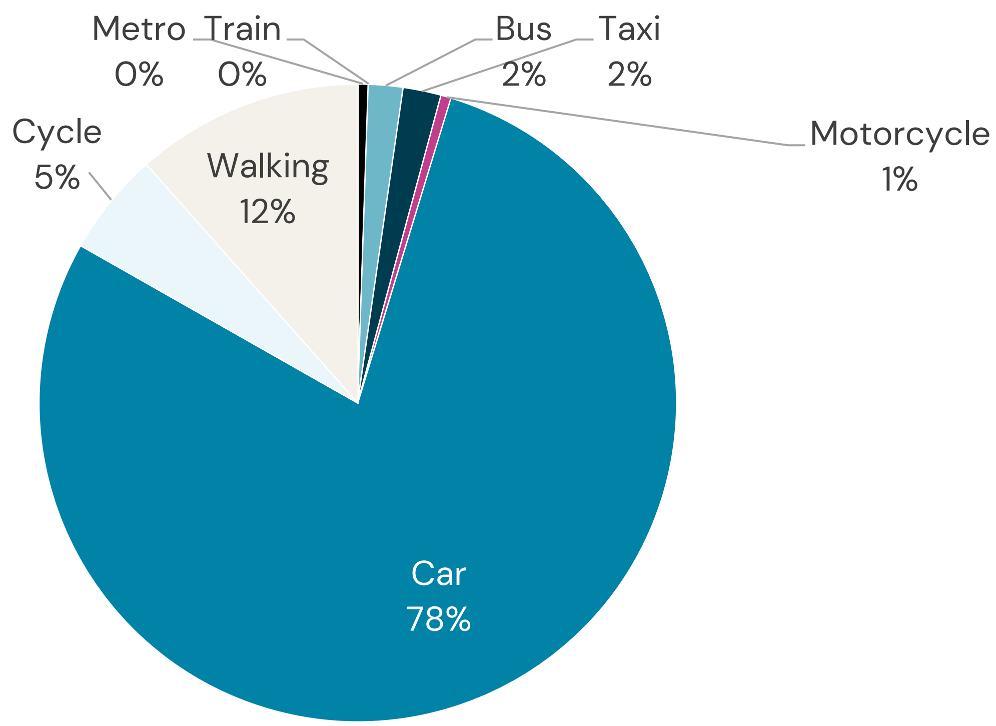
Detailed findings of the transport carbon analysis

Los Angeles – Cars are by far the most common mode used to travel to different workspaces.

In Los Angeles, significant urban sprawl, car-orientated developments and a limited public transport offering make travel by private car the most common choice for all commute trips, especially those into dense employment centres (84%). These are defined by areas with over 5,000 jobs per every square metre. That said, commuting trips to local workspace destinations (closer than 6km) are modelled to have slightly lower car use. With the sunny and temperate climate coupled with notorious levels of congestion in Southern California, strategically locating local workspaces close to existing and emerging active travel infrastructure, such as cycle lanes, e-bike hire facilities and areas with established pedestrian footway networks, could maximise the modal shift from private car to modes that have zero operational carbon emissions.



2025 Forecast mode split – City-centre workspace (Los Angeles)
Source: Arup analysis of travel data and policies (see Appendix)



2025 Forecast mode split – Local workspace (Los Angeles)
Source: Arup analysis of travel data and policies (see Appendix)

Detailed findings of the transport carbon analysis

Los Angeles – With such high car use, significant carbon savings can be achieved by limiting travel distances.

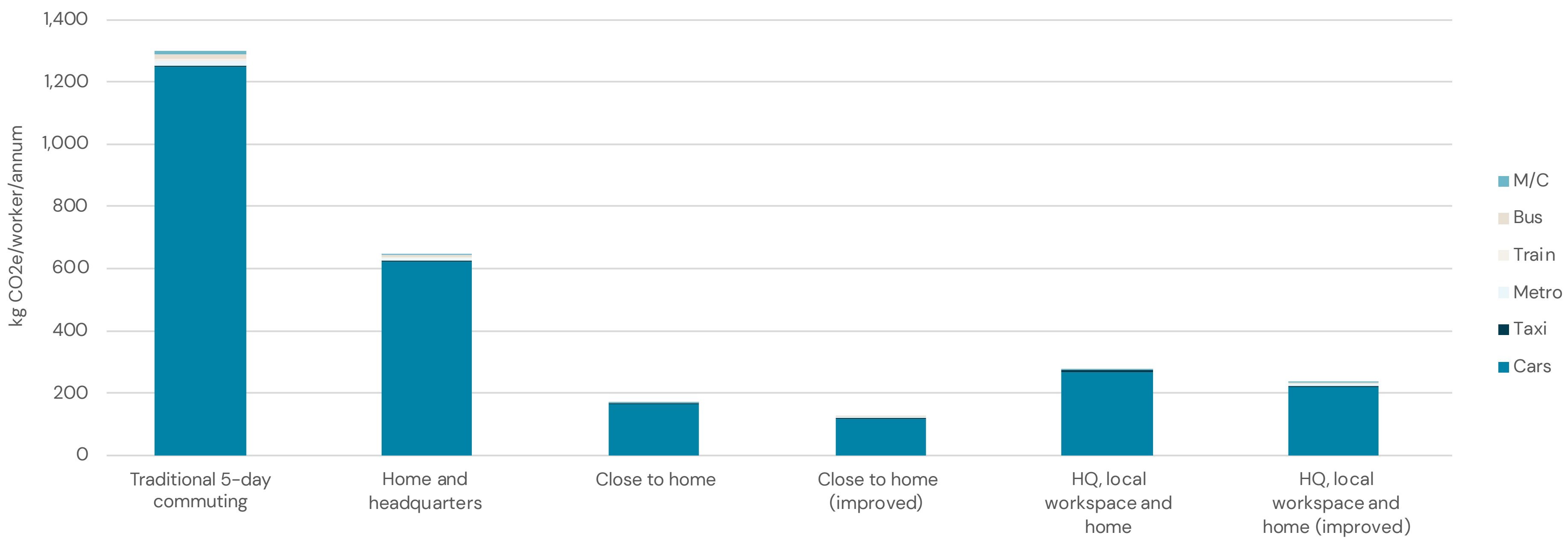
For an office employee who travels from the suburbs to an office downtown, the traditional 5-day commuting scenario generates significant carbon emissions per worker per year. When workers spend only half as much time in the city-centre workspace, however, emissions are halved.

In the close-to-home and HQ, local workspace and home scenarios, workers who travel to a local workspace all or most of the time have lower carbon impacts, 87% and 79% lower than under the traditional 5-day commuting scenario, respectively.

The majority of emissions in all scenarios come from driving. Most emissions savings, therefore, come not from workers switching to more sustainable modes but, rather, from travelling shorter distances.

This is not set in stone. Local workspaces can be located strategically to be highly accessible by sustainable modes – e.g. located on key bus corridors or high-usage cycle routes. If effective, it would be expected that a mode shift towards more sustainable travel options for journeys to these local workspaces would further reduce the carbon impacts of the close-to-home and HQ, local workspace and home scenarios.

CO_2 emissions (kg CO2e per worker per year)	Traditional 5-day commuting	Home and headquarters	Close to home	Close to home (improved)	HQ, local workspace and home	HQ, local workspace and home (improved)
City-centre workspace	1,299	649	-	-	106	106
Local workspace	-	-	170	128	170	128
Home	-	-	-	-	-	-
Total	**1,299**	**649**	**170**	**128**	**276**	**234**



Comparison of CO2e emissions per person per year by scenario (Los Angeles)
Source: Arup analysis

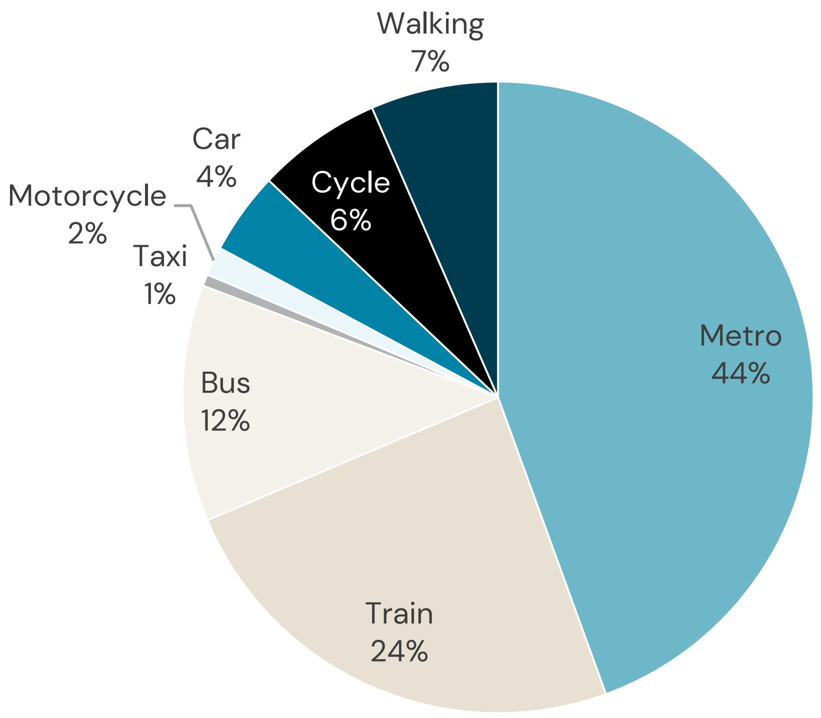
Detailed findings of the transport carbon analysis

London – Of all the cities in our study, London residents are most likely to use public transport.

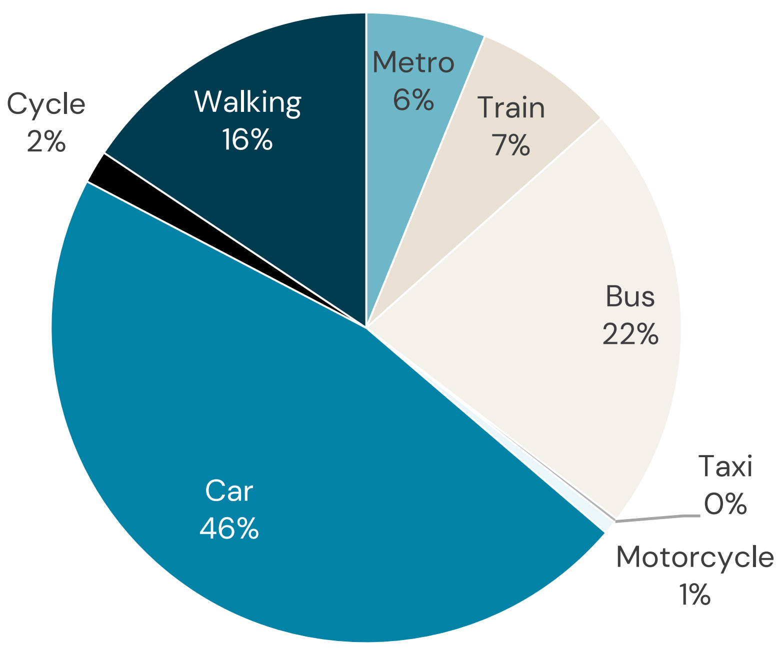
London enjoys a well-connected public transport network to the city centre, with 80% of the travel-to-work trips into Westminster and City of London being made by public transport, including National Rail, London Underground, bus services and others. Driving in central London is discouraged through the Congestion Charge, the Ultra Low Emission Zone (ULEZ) and low-traffic neighbourhoods, as well as an overall low availability and high cost of parking.

This helps explain the low proportion of commute trips made by car (4%) into Westminster and City of London.

Whilst most trips into central London are made by sustainable modes, the radial nature of public transport routes makes travelling within outer London boroughs less accessible, making driving a more natural choice. For commute trips to a local workspace, the percentage made by sustainable modes is smaller, and almost half of all trips are made by car.



2025 Forecast mode split – City-centre workspace (London)
Source: Arup analysis of census data and policies (see Appendix)



2025 Forecast mode split – Local workspace (London)
Source: Arup analysis of census data and policies (see Appendix)

Detailed findings of the transport carbon analysis

London – When workers stay closer to home, their total carbon emissions are lower, even if they use less active travel.

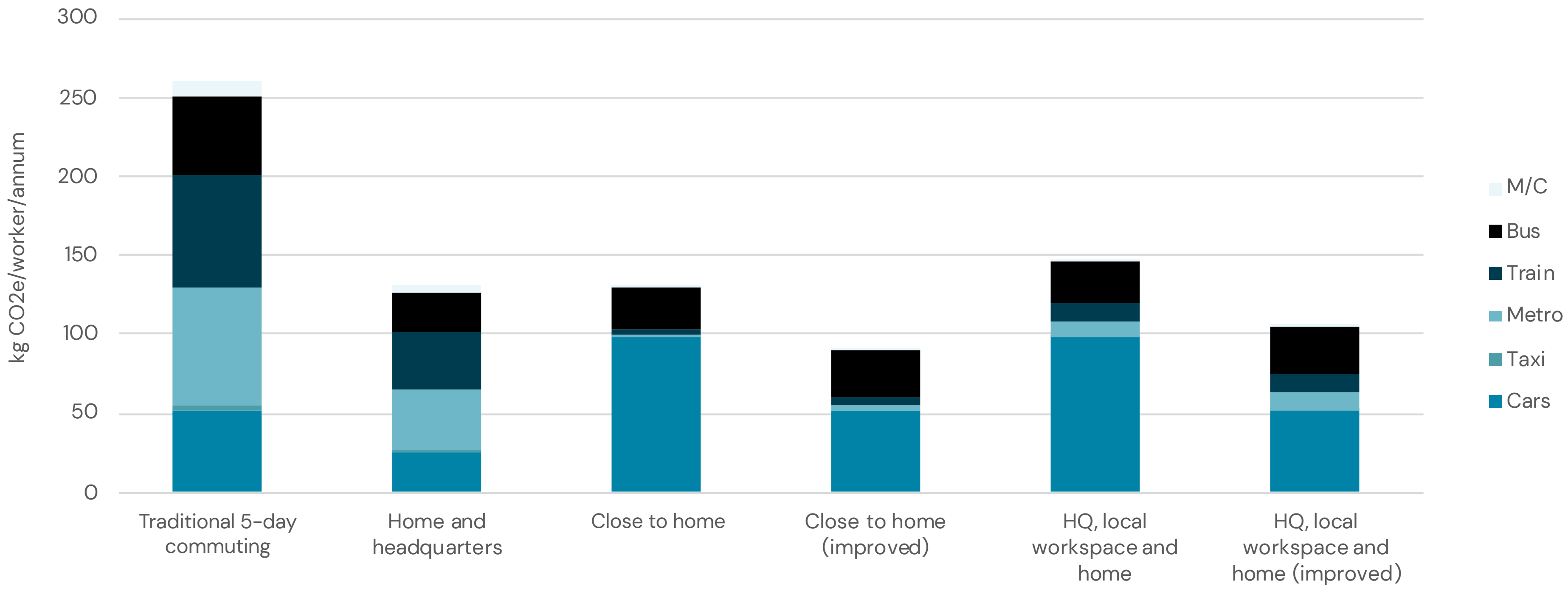
A traditional 5-day commuting pattern – travelling from home within Greater London to work in central London daily – has the highest emissions of all scenarios. This is largely due to relatively long average travel distances between central London, where most headquarter offices are, and various boroughs where the employees reside. When workers split their time between home and a central London location, carbon emissions are halved.

Carbon emissions under the close-to-home and HQ, local workspace and home scenarios are 49% and 43% lower than traditional 5-day commuting patterns. Again, the key driver is distance travelled: when workers more frequently stay closer to home, their emissions impacts are reduced.

Although the close-to-home and HQ, local workspace and home scenarios are associated with lower emissions, the travel mode shares are both more skewed to private cars. In addition to emissions, a car-orientated pattern contributes to negative impacts such as poor air quality and congestion. There may also be a high demand for car parking spaces in areas with local workspaces which may disincentivise initiatives like public realm improvements or activation of spaces for commercial use. Investment in sustainable travel and adding more local workspaces may mitigate the worst of these impacts in the future.

Critically, underlying this modelling are 2011 Census observations of travel patterns to peripheral workspace locations. It is not set in stone that travel to local workspace will remain car-orientated in the future. If the provision of improved sustainable travel options were prioritised, local workspaces could have even greater potential for carbon-emission savings in comparison to a city-centre workspace.

CO2 emissions (kg CO2e per worker per year)	Traditional 5-day commuting	Home and headquarters	Close to home	Close to home (improved)	HQ, local workspace and home	HQ, local workspace and home (improved)
City-centre workspace	261	131	-	-	16	16
Local workspace	-	-	132	92	132	92
Home	-	-	-	-	-	-
Total	**261**	**131**	**132**	**92**	**148**	**108**



Comparison of CO2e emissions per person per year by scenario (London)
Source: Arup analysis

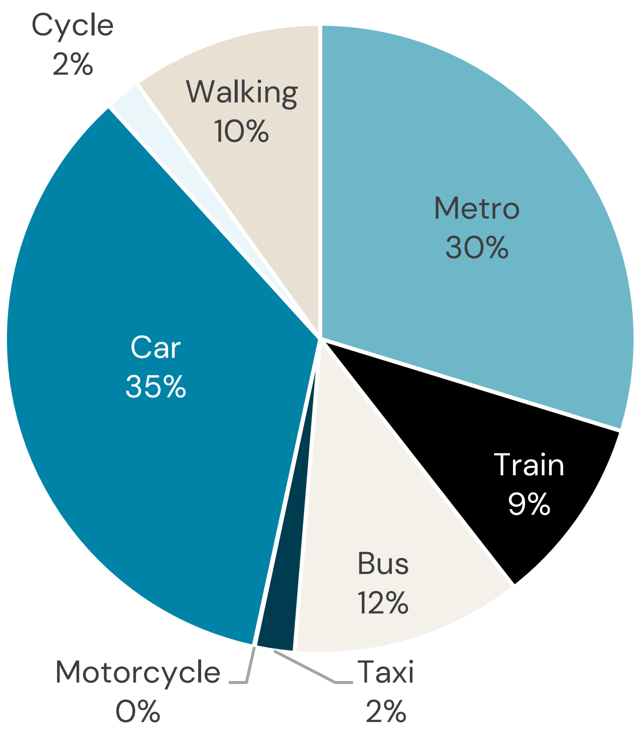
Detailed findings of the transport carbon analysis

New York City – While public transport use is high for the US, car use is very common.

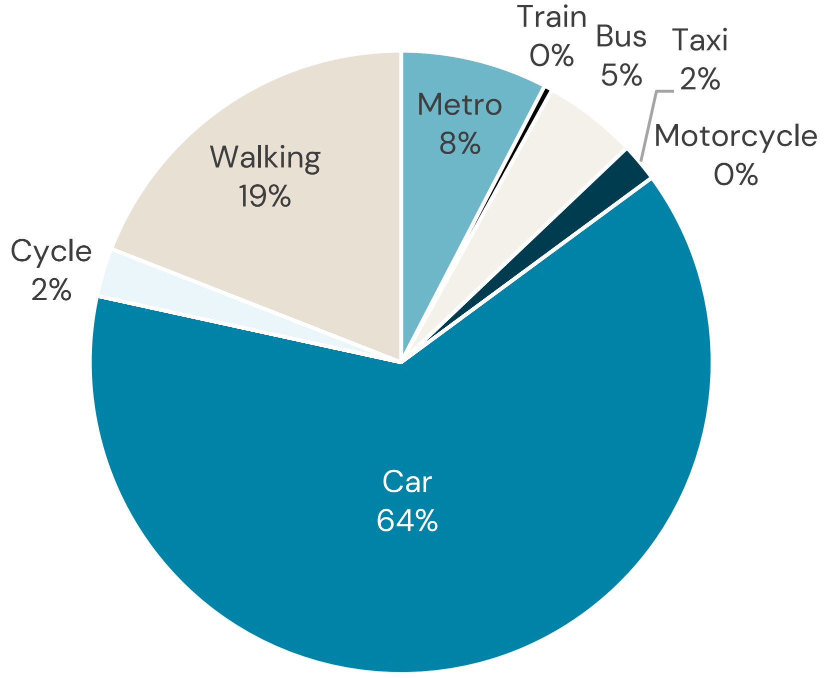
In New York City, reflective of the fact that the region's extensive public transport network is largely orientated around main commuting flows, most commute trips to employment centres are made by sustainable modes. Employment centres are defined by areas with over 5,000 jobs per every square metre. Metro (subway), train and bus services comprise more than half of all commute trips. Even so, parking availability in the city centre is more normalised than in London, a city of comparable size.

At around 40%, the drive mode share is low for the US but high for the UK.

In part, reflecting that sustainable transport options are orientated around commuting flows to the city centre, mode-share distributions to local workspace locations are modelled to be much more car dominated, with 64% of trips made by private vehicles.



2025 Forecast mode split – City-centre workspace (Manhattan)
Source: Arup analysis of travel data and policies (see Appendix)



2025 Forecast mode split – Local workspace (New York City)
Source: Arup analysis of travel data and policies (see Appendix)

Detailed findings of the transport carbon analysis

New York City – When workers stay close to home, they are responsible for 82% less carbon emissions.

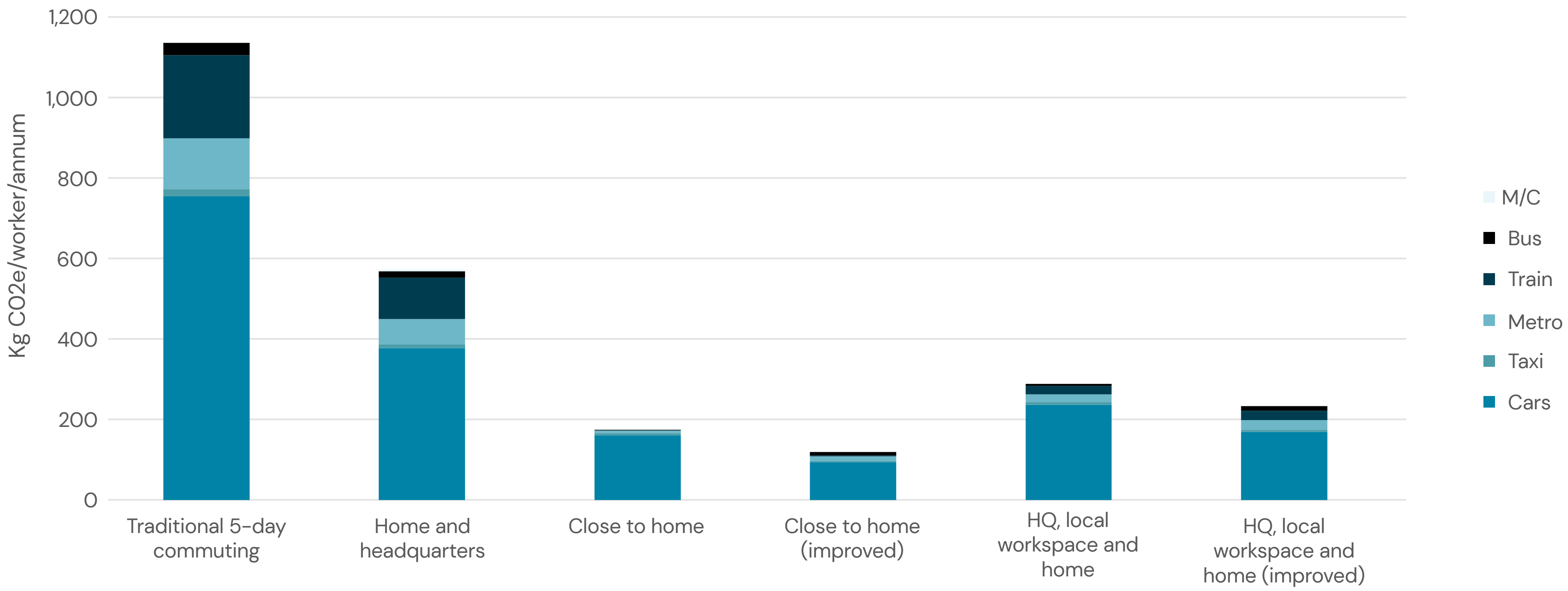
In New York City, the traditional 5-day commuting scenario generates significant carbon emissions per worker per year, even with a large proportion of commuters travelling by sustainable modes.

In the close-to-home and HQ, local workspace and home scenarios, workers who travel instead to a local workspace all or most of the time have still lower carbon impacts.

The average commute time into employment centres in New York City is 33 minutes.

The majority of emissions come from driving. Most emissions savings, therefore, come not from travellers switching to more sustainable modes but, rather, from them simply travelling shorter distances.

CO2 emissions (kg CO2e per worker per year)	Traditional 5-day commuting	Home and headquarters	Close to home	Close to home (improved)	HQ, local workspace and home	HQ, local workspace and home (improved)
City-centre workspace	1,139	574	-	-	114	114
Local workspace	-	-	176	120	176	120
Home	-	-	-	-	-	-
Total	**1,139**	**574**	**176**	**120**	**290**	**234**

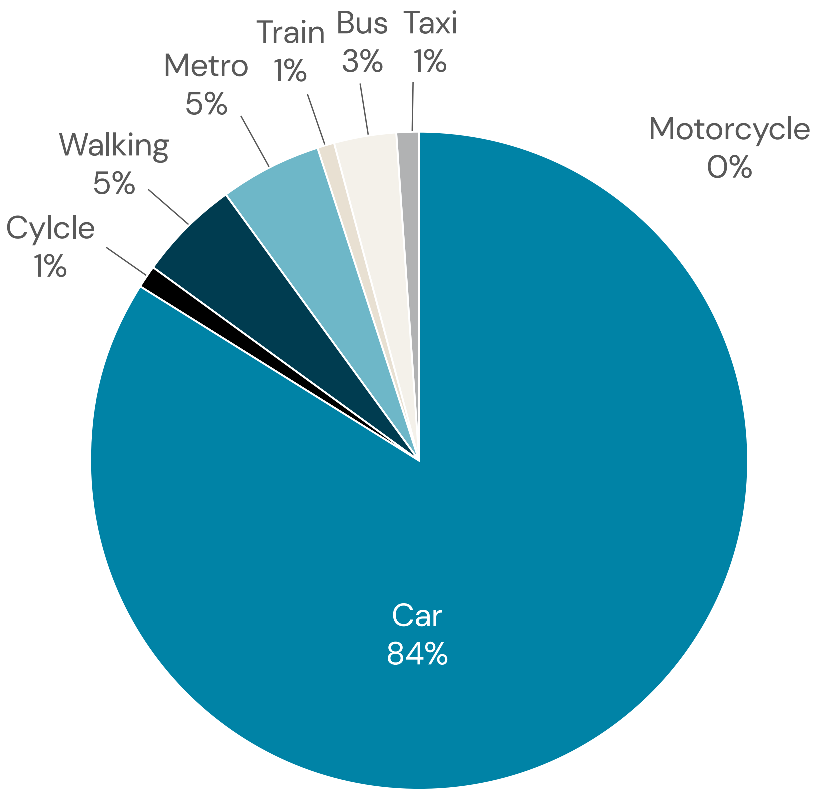


Comparison of CO2e emissions per person per year by scenario (New York City)
Source: Arup analysis

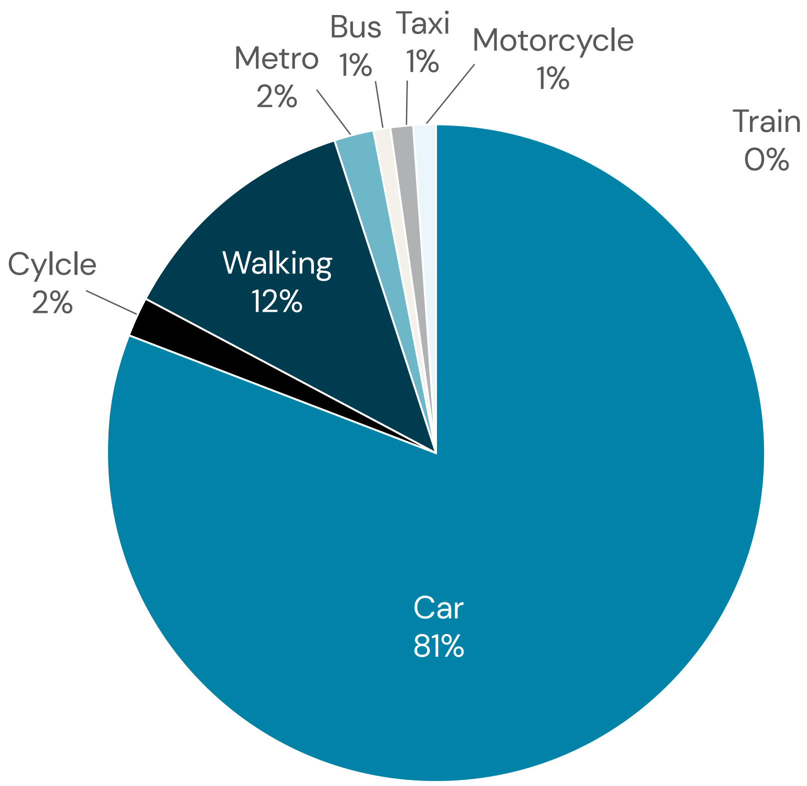
Detailed findings of the transport carbon analysis

Atlanta – Like Los Angeles, cars are the main mode for travelling to and from work.

In Atlanta, the city's high car usage is reflected in its estimated mode splits for commuter trips to city-centre and local workspace locations. Whether commuters are travelling greater distances or staying more locally, they go, overwhelmingly, by car.



2025 Forecast mode split – City-centre workspace (Atlanta)
Source: Arup analysis of travel data and policies (see Appendix)



2025 Forecast mode split – Local workspace (Atlanta)
Source: Arup analysis of travel data and policies (see Appendix)

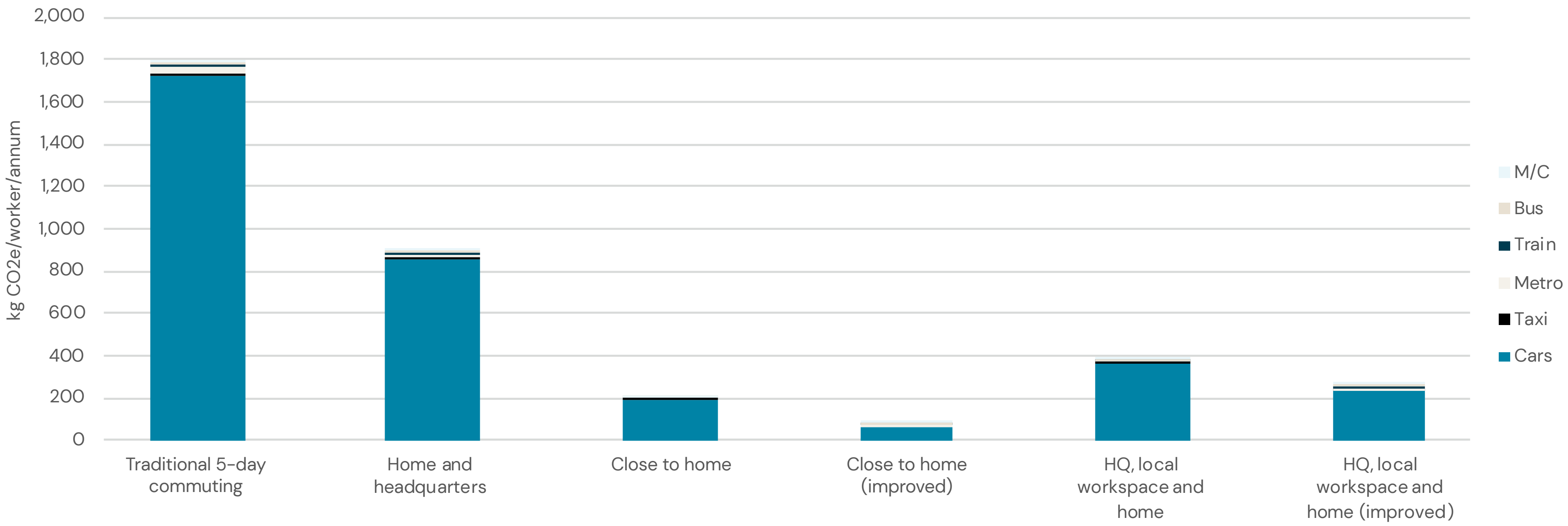
Detailed findings of the transport carbon analysis

Atlanta – Emissions from car travel account for almost all emissions in all scenarios. As such, staying close to home reduces emissions almost 90%.

In Atlanta, a heavily car-orientated city, essentially 100% of emissions in all scenarios come from private car use. In the city, the mode share distributions of travel to the city centre or more local office locations do not differ by very much: the vast majority of travellers, regardless of destination, go by car.

As with the other evaluated cities, this, again, suggests emissions savings associated with hybrid-working styles can be attributed to shorter travel distances. This also suggests that further emissions savings can be achieved if improvements to the sustainable travel offer are provided for workers opting not to travel into the city centre daily.

CO2 emissions (kg CO2e per worker per year)	Traditional 5-day commuting	Home and headquarters	Close to home	Close to home (improved)	HQ, local workspace and home	HQ, local workspace and home (improved)
City-centre workspace	1,791	896	-	-	179	179
Local workspace	-	-	201	88	201	88
Home	-	-	-	-	-	-
Total	**1,791**	**896**	**201**	**120**	**380**	**267**



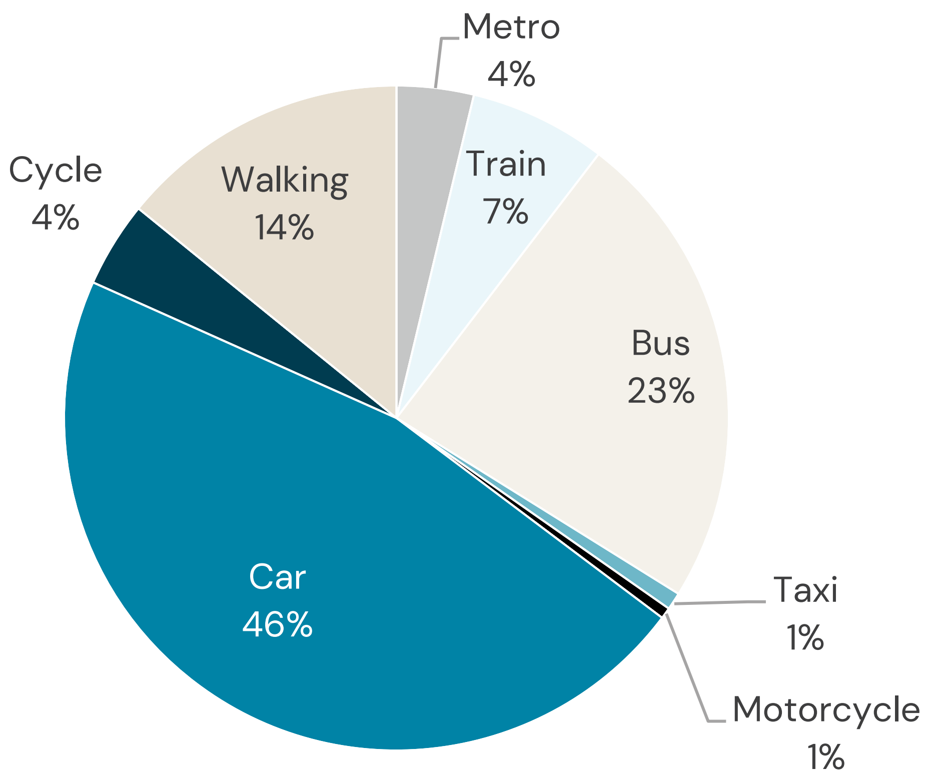
Comparison of CO2e emissions per person per year by scenario (Atlanta)
Source: Arup analysis

Detailed findings of the transport carbon analysis

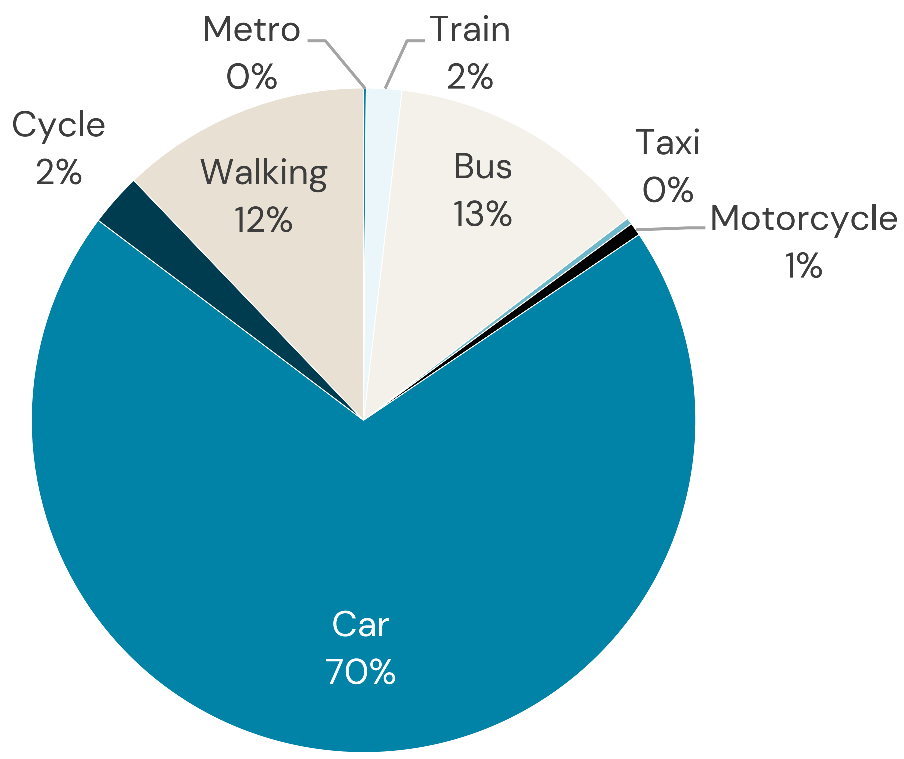
Manchester – Trips to a local workspace are less likely to be by public transport than trips to the city centre.

Even to the city centre (located within the 'Manchester' local authority), almost half of the commute trips are made by private car. Conversely, approximately half are made by sustainable modes, including walking, cycling, and public transport. In Manchester, most travel-to-work trips by public transport trips are made by bus.

The forecast mode splits for city-centre and local workspace locations differ significantly. As a result of the radial nature of the local public transport network, the proportion of trips taken by car to local workspace locations is expected to be higher than the proportion of trips taken to the city centre.



2025 Forecast mode split – City-centre workspace (Manchester)
Source: Arup analysis of census data and policies (see Appendix)



2025 Forecast mode split – Local workspace (Manchester)
Source: Arup analysis of census data and policies (see Appendix)

Detailed findings of the transport carbon analysis

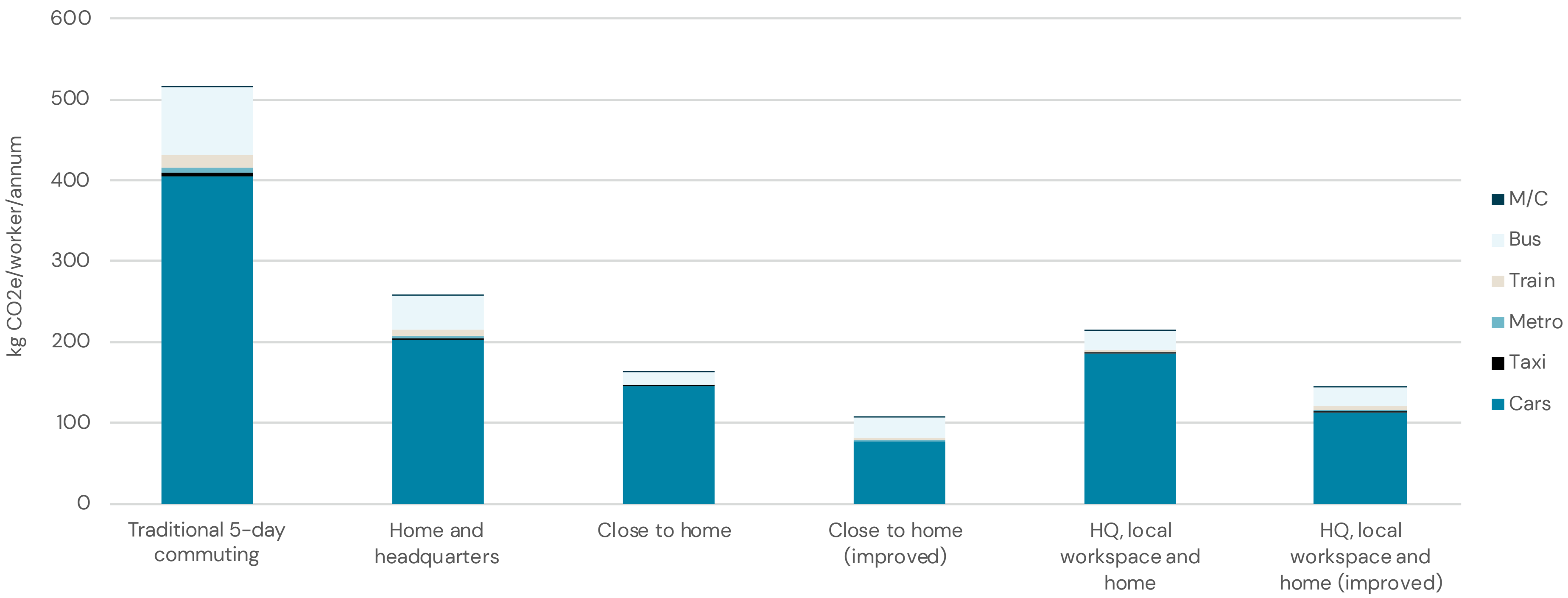
Manchester – Working closer to home reduces carbon emissions by 70%.

Mirroring the trends observed in the other cities, the traditional 5-day commuting scenario in Manchester generates the most carbon emissions per worker per year, with impacts halved when travel to work is halved under the home-and-headquarters scenario.

As in London, the close-to-home and HQ, local workspace and home scenarios in Manchester offer carbon savings over the traditional 5-day commuting option. Because there are more car trips in Manchester than in London, the scenario with the lowest emissions in Manchester is 25% higher than the scenario with the lowest emissions in London.

The majority of emissions in all scenarios come from driving. Most emissions savings, therefore, come not from travellers switching to more sustainable modes but, rather, from them simply travelling shorter distances. Where local workspaces are located strategically to be highly accessible by sustainable modes, however, it would be expected that a mode shift towards more sustainable travel options for journeys to these local workspaces would further reduce the carbon impacts of the close-to-home and HQ, local workspace and home scenarios.

CO2 emissions (kg CO2e per worker per year)	Traditional 5-day commuting	Home and headquarters	Close to home	Close to home (improved)	HQ, local workspace and home	HQ, local workspace and home (improved)
City-centre workspace	517	259	-	-	52	52
Local workspace	-	-	164	108	164	108
Home	-	-	-	-	-	-
Total	**517**	**259**	**164**	**108**	**216**	**146**



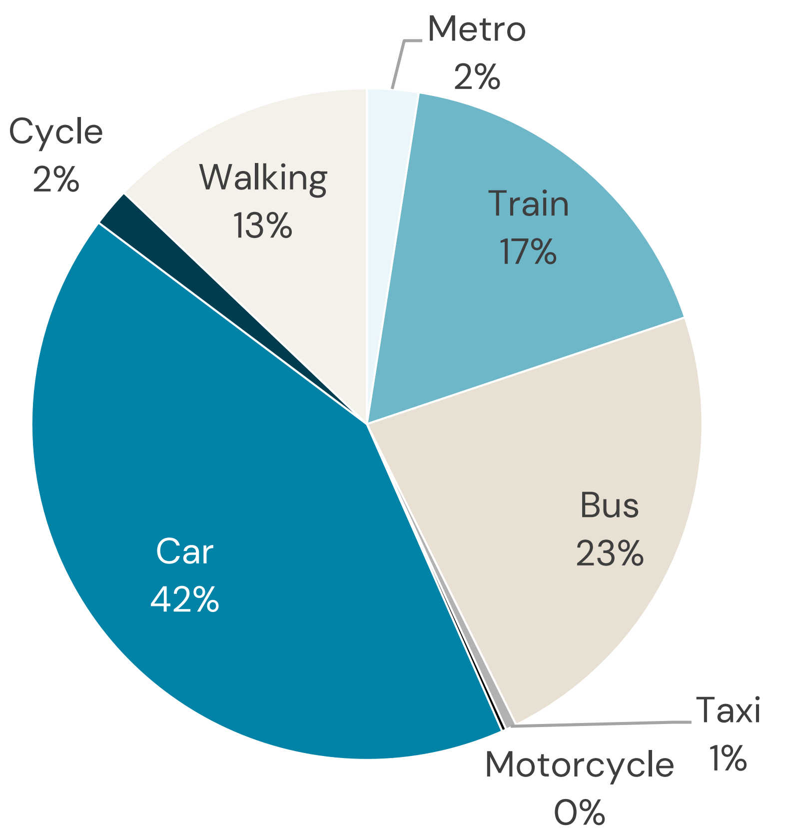
Comparison of CO2e emissions per person per year by scenario (Manchester)
Source: Arup analysis

Detailed findings of the transport carbon analysis

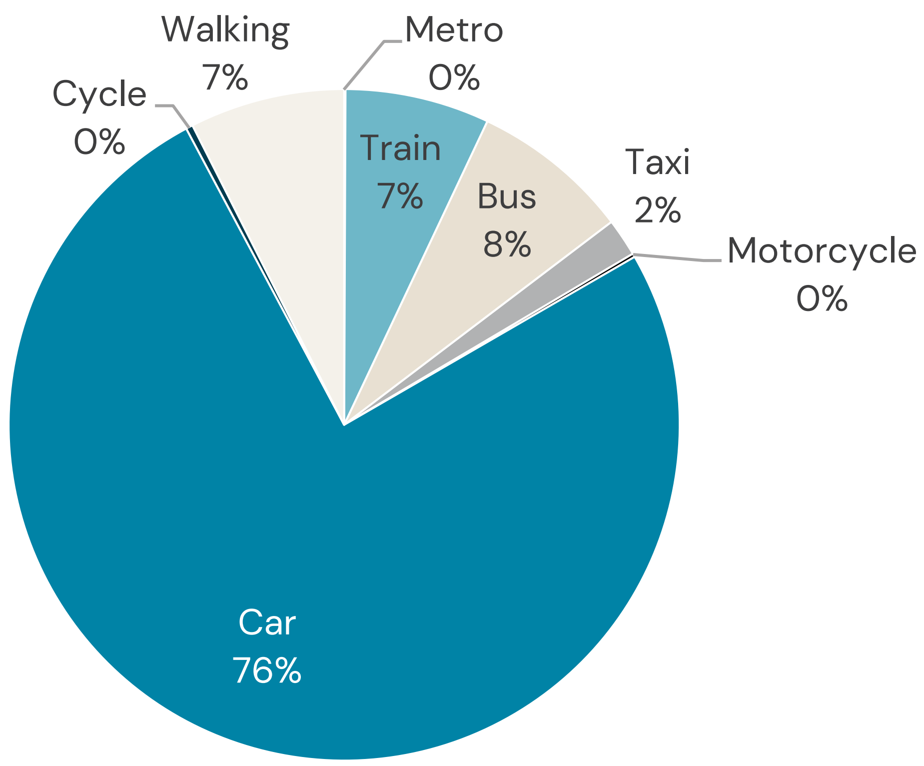
Glasgow – Mode splits between city-centre and local workspaces are similar.

As in Manchester, a large proportion of commute trips to Glasgow city centre (located within the 'Glasgow City' local authority) are made by private cars, though a significant proportion of trips are also made by sustainable modes, especially bus, train and walking.

When travelling to a local workspace, the majority of office workers go by car (76%), which mirrors the findings in other modelled cities. Public transport connectivity beyond the city centre diminishes, whilst walking and cycling are not preferred modes of choice for travelling to work.



2025 Forecast mode split – City-centre workspace (Glasgow)
Source: Arup analysis of census data and policies (see Appendix)



2025 Forecast mode split – Local workspace (Glasgow)
Source: Arup analysis of census data and policies (see Appendix)

Detailed findings of the transport carbon analysis

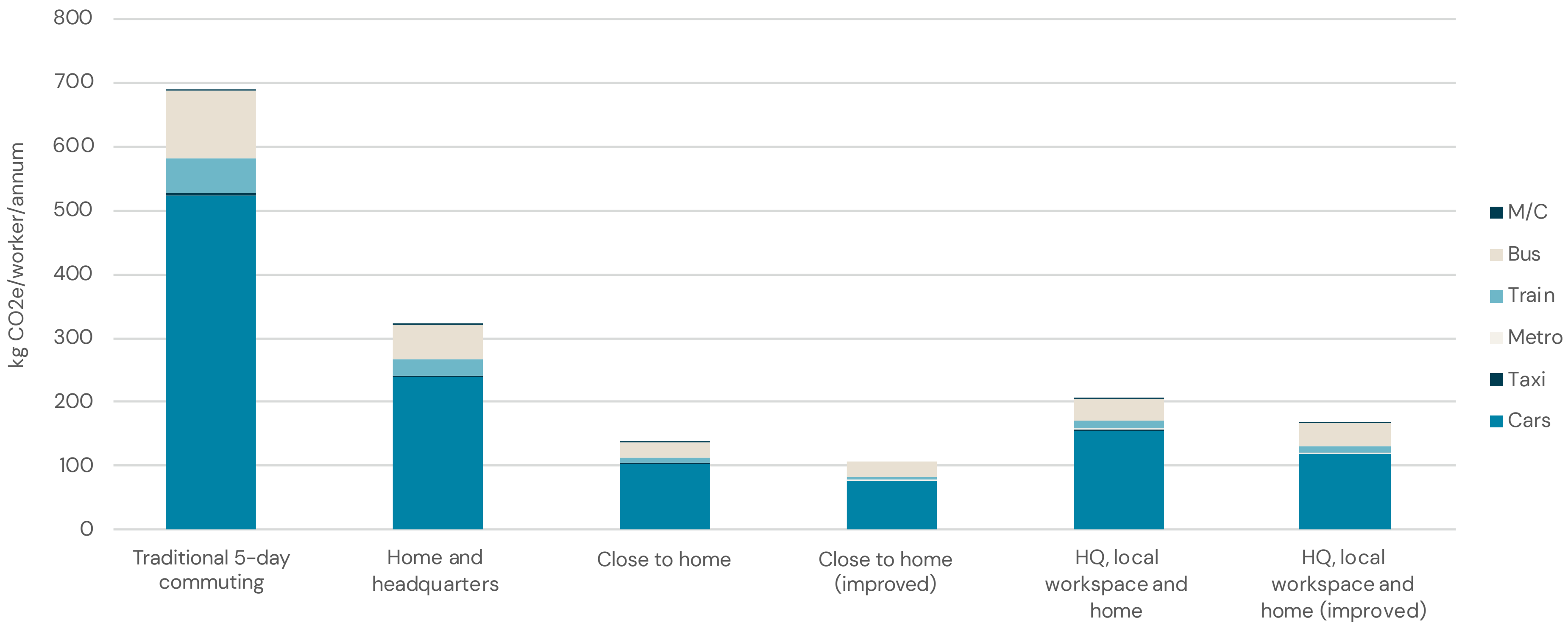
Glasgow – Working closer to home reduces carbon emissions by 80%.

The trends in Glasgow mirror those in Manchester very closely. As demonstrated in Manchester and London, workers who travel to a city-centre workspace from home daily are responsible for much higher carbon emissions than those who stay closer to home more often.

How "close to home" workers stay, of course, influences the emissions profiles, as the home-and-headquarters, close-to-home, and HQ, local workspace and home scenarios illustrate. When workers still travel long distances into city-centre locations but simply do it less frequently, as in the home-and-headquarters scenario, emissions remain relatively high.

When workers travel instead to a more local location, they cover significantly shorter distances, even though that means they will be more likely do it by relatively less sustainable modes. The distance travelled variable is key, heavily influencing total carbon emissions in London, Manchester, and Glasgow.

CO2 emissions (kg CO2e per worker per year)	Traditional 5-day commuting	Home and headquarters	Close to home	Close to home (improved)	HQ, local workspace and home	HQ, local workspace and home (improved)
City-centre workspace	689	321	-	-	69	69
Local workspace	-	-	137	107	137	107
Home	-	-	-	-	-	-
Total	**689**	**321**	**137**	**107**	**206**	**167**



Comparison of CO2e emissions per person per year by scenario (Glasgow)
Source: Arup analysis

Detailed findings of the buildings carbon analysis

Detailed findings of the buildings carbon analysis

Los Angeles – Building emissions are substantially lower for home workers.

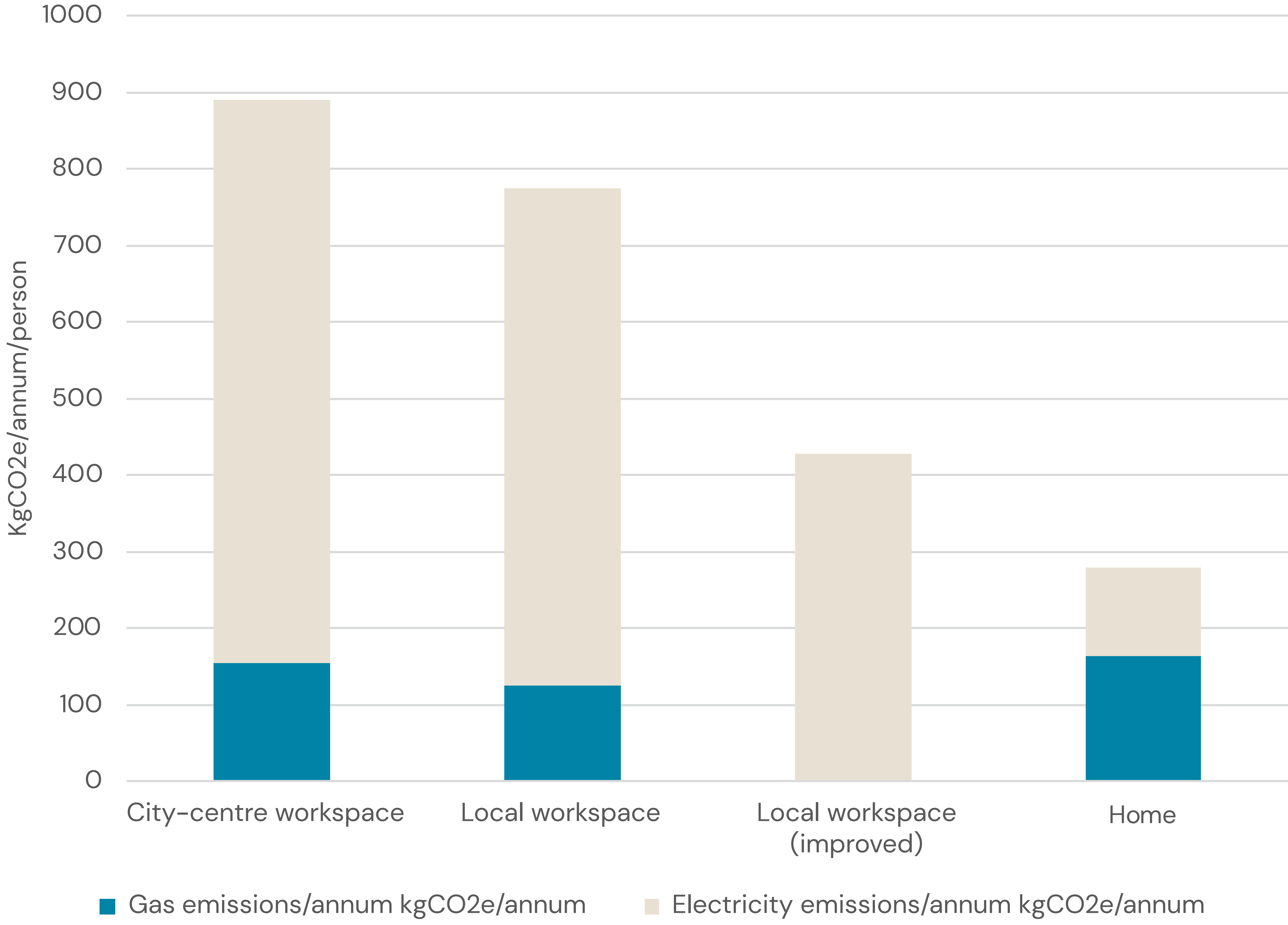
In Los Angeles, office-related emissions far exceed the emissions for home workspaces because offices in Los Angeles have a large floor area per person, leading to greater overall emissions to be distributed between the users. For example, an employee in Los Angeles working from the city-centre workspace has emissions twice as high as an equivalent person working in central London.

Office emissions are based on measured benchmarks from existing buildings. Because offices are solely used for work activities, all related emissions are distributed between the users. Home working only has emissions related to the working day, as emissions outside of this time are not specific to the work location. Both this, and a reduced heat load due to a favourable climate means home emissions are much lower than the offices in Los Angeles.

As extreme temperatures become more common due to climate change, an increased need for cooling could lead to greater emissions.

Local workspaces have similar emissions per square metre of floor area as a city-centre office. The higher utilisation rate in local workspaces provided by IWG, means that each individual person in the office is responsible for less emissions than a central, less utilised, office location.

The improved local workspace, representing the 75th percentile of similar buildings (see Appendix 2 for calculation) leads to a large reduction in emissions, largely do to moving away from gas. A high level of commitment would be required to ensure a portfolio meets the standard of the improved workspace. It is possible that the city-centre office would also be able to make the same improvements, but the local workspace was modelled because it aligns with IWG's expansion plans.



Carbon equivalent emissions associated with working location (Los Angeles)
Source: Arup analysis

Detailed findings of the buildings carbon analysis

London – Building emissions are 11% lower for workers in a local workspace compared to the city centre.

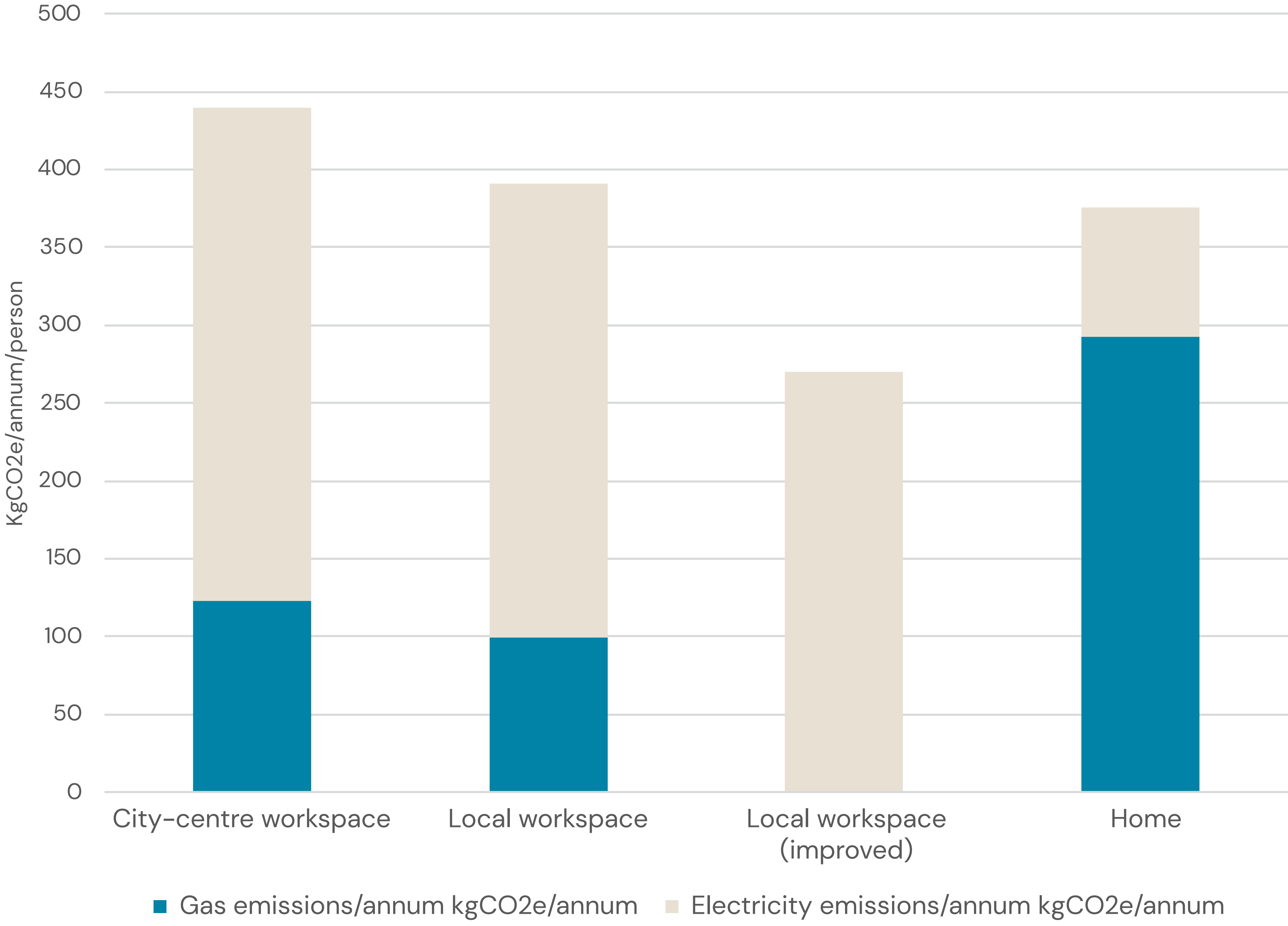
In London, emissions at the city-centre workspace come primarily from electricity used for heating, cooling and extra facilities. Although homes consume less electricity, this is partially offset due to higher gas consumption. The resulting building emissions savings for home working is around 15% when compared to the city-centre workspace.

The use of gas is the largest contributor to emissions for home working because most homes must be heated in their entirety, even if the homeworker is only in one room. Increased electrical loads due to laptop, computer or screens have less of an influence. In our analysis, we assume 30% of homes have the ability to heat just one room.

Unlike the majority of UK homes, UK offices have large cooling loads. Cooling loads and increased equipment demand are the main contributors to the increase in electrical demand in the office.

Compared with offices in the city centre, local workspaces have less emissions per square metre of floor area. Crucially, from the data provided by IWG, local workspaces have higher utilisation rates, and therefore, each person is responsible for less emissions than a central office location.

As can be seen, improving an office to best-practice standards has a considerable impact on emissions, assuming an all-electric building reduces emissions below the associated home-working emissions for the UK.



Carbon Equivalent Emissions Associated with Working Location (London)
Source: Arup analysis

Detailed findings of the buildings carbon analysis

Los Angeles – The close-to-home scenario has 41% less emissions than the traditional 5-day commuting scenario.

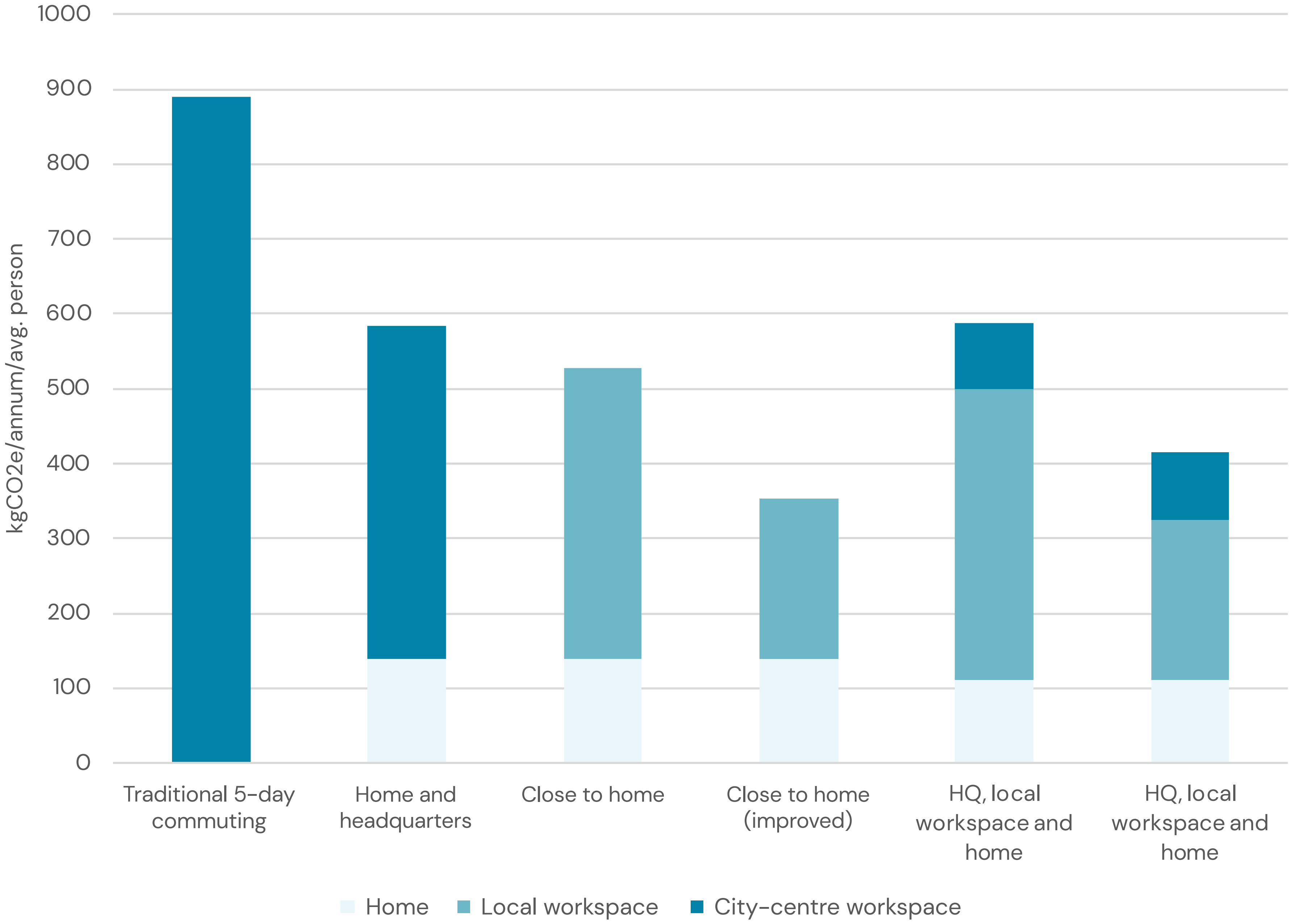
The biggest driver of emissions in all of the scenarios is the amount of time spent at an office workspace – regardless of whether it's in the city centre or local – because there is such a large difference between emissions from the home compared to emissions from an office. Comparing the traditional 5-day commuting scenario in Los Angeles and London, the annual emissions for a typical employee in Los Angeles are twice as high as those for an employee in London with the same working patterns.

All hybrid-working scenarios lower the user's emissions because they reduce the amount of time that work is done from an office.

The close-to-home scenario has the least emissions, chiefly due to the large proportion of home working. Local workspaces have less related emissions than a central office due to a higher utilisation of the workspace.

Although home-related emissions are of a similar scale to London, Los Angeles has a larger amount of provided office floor area per person, meaning that overall, the building-related emissions in Los Angeles are greater than that in London.

Two scenarios are presented to show the impact of improving the local office building stock. These are ambitious reductions which should be targeted to help move towards net zero. Doing so will help to bring office-related emissions closer to home-related emissions, however, time spent working from home in LA will remain the main driver for reducing emissions. In the future this may change, as homes aim to track towards net zero while also potentially increasing consumption through adoption of new appliances or increased proliferation of air conditioning.



Carbon Equivalent Emissions Associated with Each Scenario (Los Angeles)
Source: Arup analysis

Detailed findings of the buildings carbon analysis

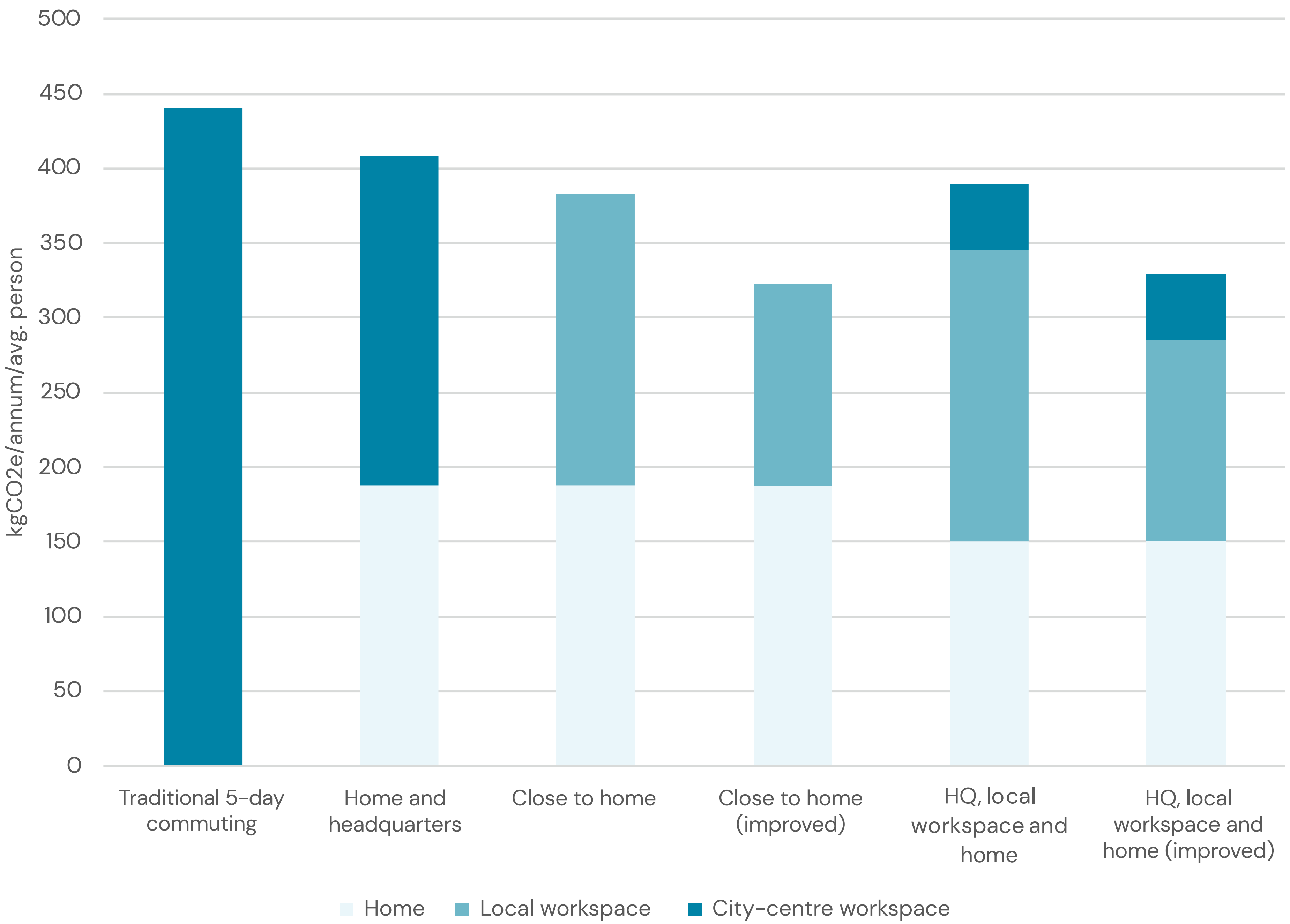
London – The close-to-home scenario has 13% less emissions than the traditional 5-day commuting scenario.

The traditional 5-day commuting scenario has the greatest associated building emissions, but this is only slightly higher than other scenarios.

Any of the three hybrid working scenarios create less annual carbon emissions. In the standard scenarios modelled, close-to-home has the least associated building emissions. By spending time at home, an employee will reduce their emissions, especially during summer, when heating is not in use. Combining this with a local office has the advantages of capturing the gains from the higher utilisation rate of a local office, creating a more efficient environment.

In reality, office occupancy fluctuates throughout the working week and is typically lower at the start and the end of the week. This would impact the potential office-related emissions as an individual working on a lower occupancy day could lead to them being responsible for an increased proportion of the building's emissions.

By improving the quality of the office stock, office-based emissions reduce and are no longer the main contributor to a scenario's emissions in the UK. These improvements would mean having a portfolio that is in the top 10-20% of performing offices in the UK. It is not currently believed that IWG's stock performs to this level and would therefore require investment in interventions to their existing stock.



Carbon Equivalent Emissions Associated with Each Scenario (London)
Source: Arup analysis

Conclusion

Conclusions

Our findings help to inform decision-making in the future.

Key findings

In all six cities' analysis and disaggregated calculations for transport and buildings emissions, traditional 5-day commuting has the largest carbon footprint.

There are clear reductions in emissions in all of the scenarios which limit the amount of time spent in a city-centre office. Even though more people may drive in the close-to-home scenario, it has the lowest carbon emissions because it reduces the amount of time in office buildings, and the total shorter commuting distance reduces the total driving distance. In Los Angeles, this reduces carbon emissions by up to 70%.

Car use and the distance travelled are the largest determinants of transport emissions. In cities with a higher rate of car use, reduced commuting distance will have larger reductions in emissions. In cities like London with high public transport ridership, the differences in transport emissions are less pronounced across the four scenarios.

For building emissions, a home workplace has the lowest emissions in both countries. There is not much difference between workplace types in London, but in Los Angeles, the carbon emissions from an office workspace are much higher than a home workplace. There is also a stark difference in emissions from offices in Los Angeles and London due to substantially higher electricity usage in Los Angeles.

Occupancy is the biggest driver of the differences between a local workspace and an office in the city centre. Local workspaces have higher occupancy, reducing the emissions per employee.

These findings have wider implications for the future of urban areas and working patterns.

In the future, the balance between all these scenarios is likely to change. For example, wider adoption of electric vehicles will dramatically reduce the tailpipe carbon emissions associated with transportation, and new building technologies and sources of energy will change the emissions characteristics of buildings.

Even with positive changes such as these, certain challenges would persist into the future. For example, car use will continue to present challenges like noise, air pollution and land consumption for parking.

Beyond carbon emissions, there are other factors which (more heavily) influence where one chooses to work. Despite having higher associated carbon emissions, there are benefits connected to city-centre workplaces, for example, camaraderie with colleagues, economic agglomeration benefits and the variety and excitement of urban life.

We should work to make every working pattern sustainable, regardless of where one chooses to work. Government, businesses and society should have an integrated strategy to reduce emissions.

These strategies should facilitate sustainable transportation networks, better integration between land use and transport planning, more rapid adoption of electric vehicles, renewable energy production, retrofits of existing buildings and energy-performance standards for new buildings.

Our findings indicate some useful short-term measure for cities to reduce emissions while they work on more system-wide changes.

More local working has a role to play in reducing an individual's carbon footprint, and regardless of where one is working, choosing to cycle, walk or take public transport would further reduce their carbon emissions.

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Appendix 1 – Detailed methodology of transport carbon analysis and transport policy context for the six study cities

Detailed methodology of transport carbon analysis

UK & US Cities

DATA GATHERING

- Census data
- National Travel Survey
- Emissions factors have been obtained from BEIS[1] (UK) and US EPA[2] databases (US)
- Transport Analysis Guidance (TAG) and local policy targets for electric vehicles (EV) uptake

DEFINING BASELINE

- Generate base travel summary statistics based on mode split, average distance travelled by mode obtained from previous step

POLICY RESEARCH TO DETERMINE MODE SPLIT IN 2025

- Policy research included London Mayor's Transport Strategy, Los Angeles 2050 LRTP
- Forecast the transport situation in 2025 based on current travel patterns and long-range objectives

MODEL SCENARIOS

- Define the split in trips based on the scenarios of interest
- For each scenario, generate trip summary tables of modelled mode split and average distance travelled by mode

INPUT TO T-CAT

- T-CAT is an Arup-developed model that has been used for calculating carbon emissions in each scenario, combining mode splits, distance travelled, emission factors, etc
- Input components of each scenario from previous step to T-CAT to calculate and compare the carbon emissions by scenarios

Caveats/assumptions:

- Available UK Census and US National Household Travel Survey data are from 2011 and 2017, respectively. Travel behaviours, patterns of work, transport infrastructure available may have changed since and may not be reflected in the data.
- Distance travelled by mode based on Origin-Destination pairs of home-work commute flows
- Proportion of electric vehicles uptake is based on variable projections from research and official databases
- Assume basic characteristics of travel patterns: annualisation factor of 225, assume trips are single purpose and occur twice per work day
- Carbon emissions only include operational carbon, no embodied carbon or carbon emissions from electricity from grid has been included

1 Greenhouse gas reporting: conversion factors 2022, Department of Business Energy & Industry Strategy, accessed online
2 GHG Emission Factors Hub (2022), United States Environmental Protection Agency, accessed online

Detailed methodology of transport carbon analysis

Components for carbon emissions calculation

Mode split

This element helps us understand the journeys made to the destinations via different modes of transport, which generate different carbon emissions. Mode share figures in 2025 have been derived from interpolating forecasts against the 2011 Census (UK) and 2017 National Household Travel Survey (US), and adjusted for relevant local changes and policy targets.

The mode splits to the local workspace have been determined by travel-to-work journeys that are 6km or shorter.

Distance travelled

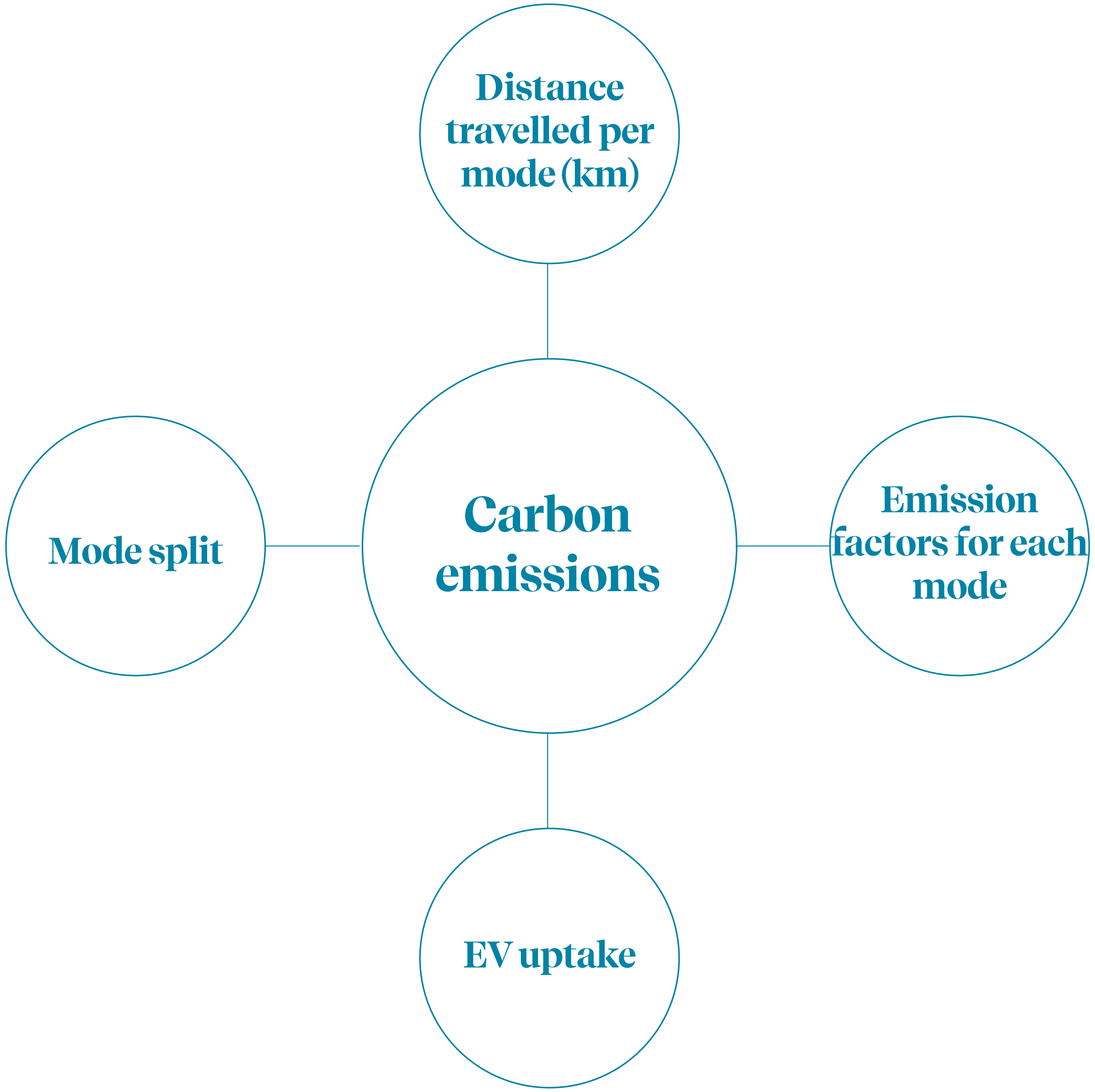
This element measures the distance travelled by each mode to the destinations. The catchment of local workspace is assumed to be an average of 20 minutes of cycle distance, which is equivalent to c.6km.

EV uptake

These figures are forecasted using relevant policy and research for each city, then adjusted for realistic rollout rates, before being applied to the relevant modes (cars, bus, rail, metro).

Emission factors

Emissions factors reflect the emissions cost of an activity. Here, factors reflecting carbon dioxide emissions per distance travelled to work were applied. Emission factors differ between transport modes and countries/regions.. The emission factors per transport mode have been applied to the above formula to provide an output in carbon emissions in kg per worker per year.



Components of carbon emissions calculation

Context: transport infrastructure and policy goals

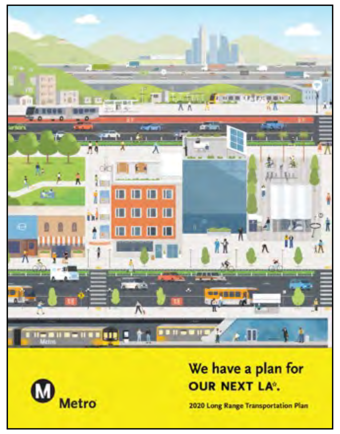
Setting the scene

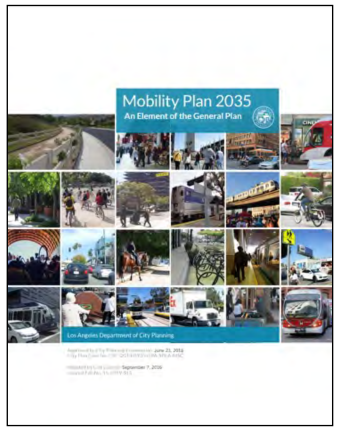
Los Angeles

In Los Angeles, heavy investment in roads has shaped and reshaped the city over the past century. Travel by car is by far the most common way to commute, with almost 90% of commute trips to employment centres being made by car.

Still, public transport plays an important role in the city. A bus system with high coverage includes two rapid bus lines. Five light rail and two heavy subway metro lines operate, and several new lines and extension projects are currently underway. Additionally, commuter rail services provide key connectivity for commuters.

Reflecting the car-dominated nature of the city, LA's 2020 Long Range Transportation Plan (LRTP) did not establish mode share targets, but it does set a goal for an 81% increase in public transport trips by 2050.





London

London Underground, heavy and light rail managed by Transport for London (TfL), local buses, and local and regional rail services provide public transport connectivity throughout the city.

In central London, the Congestion Charge discourages all vehicle travel into the city centre, and the Ultra Low Emission Zone, which operates across a wider area of Greater London, discourages travel by highly polluting vehicles. Accordingly, over 90% of commute trips into Central London are made by sustainable modes. In all of Greater London, more than 70% are.

According to the Mayor of London, TfL spends £15-30 per person per year on walking and cycling projects, far above the England average of £7.65.

The 2018 Mayor's Transport Strategy established ambitious goals for Greater London, including that 80% of all trips in the capital will be made by walking, cycling, or public transport by 2041.

Context: transport infrastructure and policy goals

Setting the scene

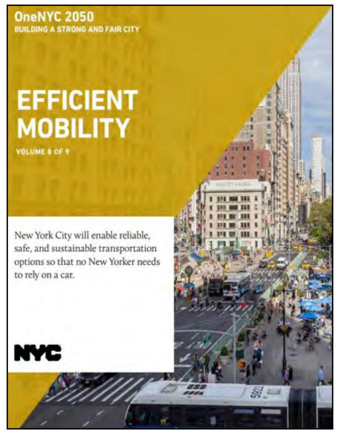
New York City

New York City is the largest city in the United States, a global cultural and financial capital. The city's economy is one of the largest in the world.

The region is a vast urban conurbation spanning at least three states and dozens of counties. Local, regional, and inter-regional transport provision falls under a complex mix of local, state, federal, and quasi-public organisations.

The public transport offer in New York City is vast. The city has the highest public transport ridership of anywhere in the US. Commuter rail services from all directions provide more regional connectivity, while local and express buses also play a critical role in the region.

Building on existing success, New York City plans to have 80% of trips made by sustainable modes by 2050; today, approximately 57% of commute trips into dense employment centres are made by walking, cycling, and public transport.



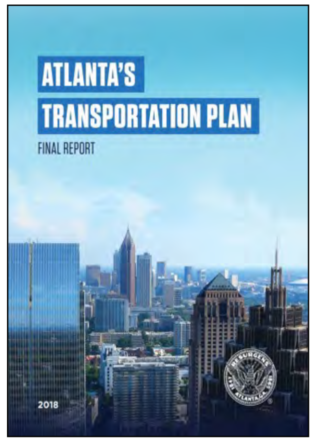
Atlanta

In contrast to New York City, Atlanta is a regional metropolis, the capital of the southern state of Georgia. The city's population is slightly smaller than Glasgow's – 500,000 people, compared to 650,000 – but Atlanta's city region is far larger – home to 6.1 million people, compared to 1.2 million.

Transport in Atlanta is a varied offer. It is notably a very car-orientated city, with poor national ratings for air quality, congestion, and commute times. Approximately 87% of commute trips into dense employment districts are made by car.

Still, the city has seen investment in sustainable travel. The MARTA rail network, bus network and streetcar carry more than 50,000,000 riders annually.

In part, reflecting the city's high car usage, its future transport plan aspires that alternatives will be improved.



Context: transport infrastructure and policy goals

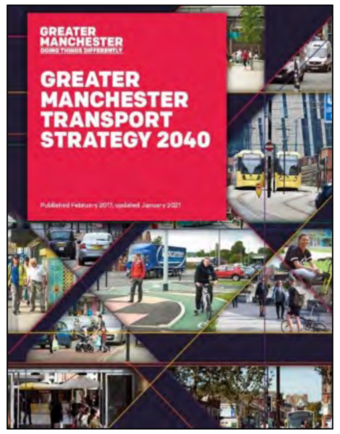
Setting the scene

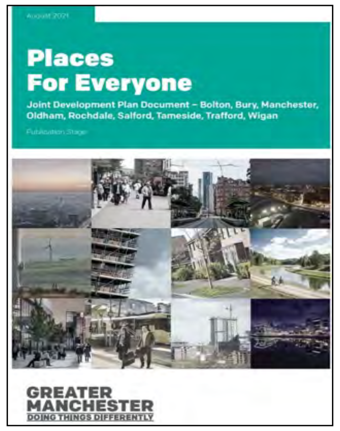
Manchester

Greater Manchester is, save for Greater London, the most populous urban area in the UK. Unlike London, however, the car plays a more significant role in transport in Manchester: 49% of commute trips into central Manchester, and 72% across the whole region, are made by car.

Travel by sustainable modes plays an important role in residents' and workers' mobility, however. The city is a key hub for local, regional and inter-regional rail services. The tram system is the largest in the UK. The large bus network – including a good night-bus system – is overseen by Transport for Greater Manchester. Finally, the cycling network is undergoing continual expansion.

Planners in Manchester have envisioned that, by 2040, 50% of all journeys will be made by sustainable modes, a goal supported by investment in public transport, walking, and cycling provision across the city region.





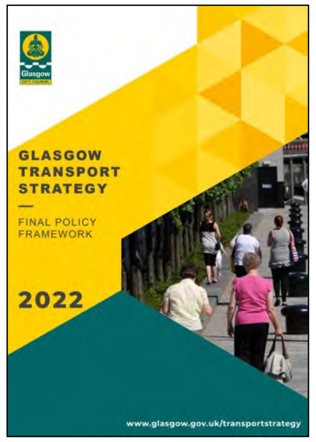
Glasgow

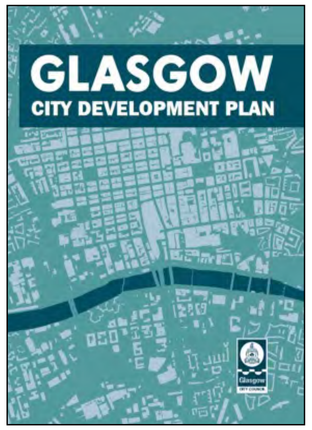
Glasgow is Scotland's largest city, and third in the UK, smaller only than London and Birmingham. It is a major employment centre, drawing commuters from throughout the wider city region during peak hours.

The city is orientated around its infrastructure, with a grid road pattern in the city centre and extensive motorway connectivity with its surroundings. As in Manchester, car use is more common in Glasgow than in London, with almost half of all commute trips into Central Glasgow made by private vehicle.

Still, rail use is strong in the region, with extensive local and regional rail services, linking Glasgow to its suburbs, Edinburgh and beyond.

As elsewhere, Glasgow aspires to support more sustainable travel, with a policy goal that vehicle trips to the city centre are reduced, and walking, cycling, public transport and shared mobility all support a larger proportion of trips in the city by 2030.





Appendix 2 - Detailed methodology of buildings carbon analysis

Detailed methodology of buildings carbon analysis

The key factors in our calculations for building emissions

Work-based emissions from the three workspaces were calculated by estimating energy usage from each workspace, the fuel mix to provide the required energy and the emission factors for each fuel type in the given year.

'Work-based' emissions are defined as the emissions resulting solely from work activities, which take place as part of the typical working day (09:00-17:00) or are otherwise required to support the working day.

Different calculation methodologies have been used between home working and office working (city-centre and local workspaces). Calculation methodologies, inclusions/exclusions and assumptions are described on the next page.

Detailed methodology of buildings carbon analysis

Methodology: Home emissions

BUILDING TYPOLOGY

- Location-specific standard building typology including fabric build up

CONDITIONED AREA

- Regional comfort criteria
- Average total dwelling size
- Average typical single-room for home working
- Number of dwellings with the ability to control a single space

ELECTRICAL, DHW, HEATING AND COOLING LOADS

- Total loads that are attributed to home working between the specified working hours
- Equipment loads
- Heating and cooling
- Lighting
- Hot water
- Miscellaneous

SYSTEMS AND FUEL TYPE

- Proportion of system adoption in the specified city
- Fuel source associated with each system

EMISSIONS

- Calculate the carbon emissions using local carbon factors

Methodology: Office emissions

OFFICE BENCHMARKS

- Location-specific values for typical office benchmark
- Split by fuel type

CONDITIONED AREA

- Average typical floor area per office worker
- Scaled by utilisation for non-standard office stock

EMISSIONS

- Calculate the carbon emissions using local carbon factors

Detailed methodology of buildings carbon analysis

Home emissions calculation

- Home emissions relate to the additional energy consumed at home that would not otherwise have been consumed if the worker carried out work activities at the office workspace.
- The main inclusions and exclusions are shown, right.
- Space heating and cooling calculations are carried out using information on the average building stock, and annual weather profiles to calculate required heating and cooling loads. Final energy consumption is calculated by assigning these heat loads to the proportional mix of heating/cooling technologies.
- The required home-working energy is averaged for a kWh/day basis, and multiplied by the number of assumed home-working days in the year to arrive at a kWh/person/annum.

Category	Included energy	Excluded
Small power	• 1 computer and monitor screen • Kettle usage (3 boils/day) • Microwave usage (1 use/day) for cooking	• Telecommunications (video conferencing) • Increased data centre usage • Small appliances (desktop fans etc.) • Printers: assumed not required at home. • White goods (dishwasher, washing machine, fridge/freezer): assumed negligible difference in energy to office-based working
Lighting	• Lighting for the working area in non-daylight hours	• Additional room lighting
Space heating	• Additional heating in working hours • Proportion of whole house to single room heated dependent on number of households with ability to separately control room heating.	
Domestic hot water	• Shower usage for proportion of cyclists who shower, having a shower at home instead • Hot-water tap usage for personal hygiene	• General occupant showering: assumed the same level home working to office
Space cooling	• Additional cooling in working hours. • Proportion of whole house to single room cooled dependent on number of households with ability to separately control room cooling	

Detailed methodology of buildings carbon analysis

Home emissions: space heating

- Emissions relating to space heating are calculated based on research on dwelling typologies, and assigning construction types.
- Each building typology has building areas, form-factors, window and wall areas, and construction values, which are used to calculate annual heat demand figures.

- Heating is only considered within the working day (09:00-17:00).
- A total average heat demand for the 'average home' is calculated by using the proportion of number of buildings in each typology.

- Research on heating systems and fuel sources are applied to the total average heat demand to provide annual consumption values for each fuel source.
- Emission factors are then used to calculate annual emissions associated with space heating.

BUILDING TYPOLOGY

Defining different domestic typologies. For each typology use; form-factor, window-to-wall ratio, construction types and performance values (u-values and g-values).

HEATED AREA

For each typology, defining average total dwelling size, and typical single room for home working.

Defining number of dwellings with ability to control heat to individual room only.

HEAT GAINS AND LOSSES

Calculating heat gains and losses in space to determine overall demand. Weather files used for external temperatures and solar irradiance.

Heat gains: people, equipment, lighting, solar.

Heat losses: infiltration, conduction, ventilation.

CONDITIONS

Defining set-points for which homes are heated to, and to define heat losses.

HEATING SYSTEM & FUEL

Overall proportion of heating systems to provide heating demand. Each system will have an associated fuel source and efficiency.

HEATING EMISSIONS

Multiplying total heat demand with system efficiency, and emission factor for each fuel-source to get total annual emissions.

Detailed methodology of buildings carbon analysis

Home emissions: space cooling

- Emissions relating to space cooling are calculated based on research on dwelling typologies, and assigning construction types.
- Each building typology has building areas, form-factors, window-and-wall areas, and construction values, which are used to calculate annual cooling demand figures.

- Cooling is only considered within the working day (09:00-17:00).
- London is assumed to have no homes with cooling systems.
- A total average cooling demand for the 'average home' is calculated by using the proportion of number of buildings in each typology.

- Research on cooling systems and fuel sources are applied to the total average heat demand to provide annual consumption values for each fuel source.
- Emission factors are then used to calculate annual emissions associated with space cooling.

BUILDING TYPOLOGY

Defining different domestic typologies. For each typology, defining; form-factor, window-to-wall ratio, construction types and performance values (u-values and g-values).

COOLED AREA

For each typology, defining average total dwelling size, and typical single room for home working.

Defining number of dwellings with ability to control cooling to individual room only.

HEAT GAINS AND LOSSES

Calculating heat gains and losses in space to determine overall demand. Weather files used for external temperatures and solar irradiance.

Heat gains: people, equipment, lighting, solar.

Heat losses: infiltration, conduction, ventilation.

CONDITIONS

Defining set-points for which homes are cooled to, and to define heat losses.

COOLING SYSTEM & FUEL

Overall proportion of cooling systems to provide heating demand. Each system will have an associated fuel source and efficiency.

COOLING EMISSIONS

Multiplying total heat demand with system efficiency, and emission factor for each fuel source to get total annual cooling emissions.

Detailed methodology of buildings carbon analysis

Home emissions: DHW

- Emissions relating to DHW are calculated based on research on typical consumption values for office working.
- Volume of water used for showers is equivalent to a standard shower, multiplied by the portion of office workers who cycle to the office location.
- The total consumption is calculated using typical fuel types and system efficiencies.
- Emission factors are then used to calculate annual emissions associated with DHW.

HOT WATER CONSUMPTION	CONDITIONS	HOT WATER SYSTEM & FUEL	HEATING EMISSIONS
Additional home hot water consumption is in line with the typical office consumption	Defining set-points for which water is heated to, and for how long	Typical hot water system and fuel type	Multiplying total heat demand with system efficiency, and emission factor for each fuel-source to get total annual emissions.

Detailed methodology of buildings carbon analysis

Home emissions: lights, equipment and other

- Emissions relating to lights and equipment are calculated based on typical usage that would be required to adapt a space to accommodate for home working.
- All emission from lights, equipment and other e.g., cooking and powering a kettle have been considered only within the working day (09:00-17:00).
- Emission factors are then used to calculate annual emissions associated with space cooling.

ADDITIONAL CONSUMPTION	USAGE TIMES	POWER CONSUMPTION	EMISSIONS
Establish extra emissions that will take place when adjusting a home to accommodate a workspace. Attempt to ensure all relevant applications that will be included in the office are included in the home.	For each addition emission, establish a length of time and frequency that the item will be used.	Use typical power consumption values.	Multiplying total extra consumption by emission factors.

Detailed methodology of buildings carbon analysis

Home - assumptions/sources

Parameter	London	Los Angeles
Building		
House size	LETI Climate Emergency Retrofit Guide (LETI,2021)	Property Shark (PropertyShark, 2022)
Form factor	LETI Climate Emergency Retrofit Guide (LETI,2021)	LETI Climate Emergency Retrofit Guide (LETI,2021)
Comfortable room temperature	Guide A (CIBSE, 2021)	Standards 62.1 & 62.2 (ASHRAE, 2022)
Building fabric	LETI Climate Emergency Retrofit Guide (LETI,2021)	Standards 62.1 & 62.2 (ASHRAE, 2022)
System	UKGBC, Net Zero Whole Life Carbon Roadmap	Assumption
Equipment		
Laptop	Guide A (CIBSE, 2021)	Guide A (CIBSE, 2021)
Screen	Guide A (CIBSE, 2021)	Guide A (CIBSE, 2021)
Lights	Guide A (CIBSE, 2021)	Guide A (CIBSE, 2021)
Person	Guide A (CIBSE, 2021)	Guide A (CIBSE, 2021)
Carbon factors		
Gas	Updated Energy and Emissions Projections (BEIS, 2020)	Emissions & Generation Resource Integrated Database (EPA, 2021)
Electricity	Future Energy Scenarios 2022 (National grid, 2022)	Emissions & Generation Resource Integrated Database (EPA, 2021)

Detailed methodology of buildings carbon analysis

City-centre workspace calculation

- City-centre workspace emissions relate to the energy consumed within the office setting.
- Office-based emissions are calculated per person to equate to the home-working equivalent additional emissions.
- The average annual energy and emissions per person from office-based working are derived from:
  - Energy data per fuel source from in-use audits of commercial offices.
  - Average workstation size.
- An assumed rate of desk utilisation (%) is used to convert the city-centre workspace emissions to the local workspace.
- Any emissions that will be proportional to the number of workers e.g. equipment loads must also be scaled.
- This calculation inherently includes energy outside of the occupant's working day, e.g. for standby loads, or cleaning/ security occupied hours. This is included in the energy and emission totals, as this energy would not otherwise be consumed and is therefore a requirement of the office-based working.

Parameter	London	Los Angeles
Energy sources	Electricity Gas	Electricity Gas
Operational energy benchmark source	The Real Estate Environmental Benchmark (REEB)	Building Performance Database (BPD)
Workstation size (m2)	9.6 NLA	30 GLA
Utilisation rate (%) assumed within benchmark	65%	65%
Total emissions per worker/annum	440	306

Detailed methodology of buildings carbon analysis

Local workspace calculation

- For the purposes of this study, local workspaces are assumed to be of the same construction, typology, and usage as the city-centre workspaces.
- The defining difference in the two workspaces are the higher utilisation rates for local workspaces. Therefore, the effective density of the workspace is higher, which results in a lower overall energy/worker/ annum. This is shown, right.
- Local workspaces have greater potential for energy efficiency such as:
  - Likely less storeys/floors than city-centre counterparts, meaning a greater proportion of roof space is available for renewable technologies (heat pumps, PV panels etc.)
  - Surrounding areas potentially less polluted (air and noise) from traffic emissions, which provides greater opportunity for natural ventilation/ mixed-mode.
- These opportunities have not been included for local workspaces in this study.

	London	London (improved)	Los Angeles	Los Angeles (improved)
Source	The Real Estate Environmental Benchmark (REEB)	UK Green Building Council (UKGBC)	Building Performance Database (BPD)	Building Performance Database (BPD)
Gas Benchmark (kWh/m2)	51 (NLA)	0 (NLA)	20 (GLA)	0 (GLA)
Electricity Benchmark (kWh/m2)	159 (NLA)	148 (NLA)	114 (GLA)	75 (GLA)
Benchmark city-centre emissions (kgCO2e/person/annum)	440	292	890	485
City-centre utilisation rate (%)	65%	65%	65%	65%
Local workspace utilisation rate (%)	80%	80%	80%	80%
Resulting emissions (kgCO2e/person/annum)	367	270	774	428

Detailed methodology of buildings carbon analysis

Office emissions

- Office benchmarks, based on real data from existing buildings are obtained depending on the location.
- Benchmarks are split by fuel type that are used within the location.
- Loads are multiplied by the prevision of floor area per person, including amenities.
- Total emissions are scaled to account for utilisation rates. Higher rates, result in lower emissions as the spaces are used more efficiently.
- When emissions are adjusted for utilisation rates, emissions that are proportional to utilisation, such as equipment loads, must also be scaled.
- Emission factors are then used to office emissions .

OFFICE BENCHMARKS	TYPICAL FLOOR AREA	UTILISATION RATES	ADJUSTMENT (IF APPLICABLE)	EMISSIONS
Typical location-specific benchmarks for existing buildings.	Typical floor area per person for a location. Including amenity and circulation spaces.	Utilisation rates are a measure of how close to full capacity a building is. Scale the benchmarks by the utilisation rate.	Scaling by utilisation doesn't account for emissions that are proportional to the number of people. Emissions, like equipment loads, also need to be scaled.	Multiply scaled load by emission factor for each fuel source to get total annual emissions.

Detailed methodology of buildings carbon analysis

Home - assumptions/sources

Parameter	London	Los Angeles
Building		
Office benchmarks	The Real Estate Environmental Benchmark (REEB, 2020)	Building Performance DataBase (BPD, 2021)
Improved office benchmark	Net zero carbon: energy performance targets for office (UKGBC, 2020)	Building Performance DataBase (BPD, 2021)
Utilisation rates (city-centre workspace)	Occupancy Planning Annual Report (JLL, 2017)	Occupancy Planning Annual Report (JLL, 2017)
Utilisation rates (local workspace)	Provided by IWG (IWG, 2022)	Provided by IWG (IWG, 2022)
Workstation size	Update 2022: A position paper (BCO, 2022)	Building Performance DataBase (BPD, 2021)
Equipment		
Gas	Updated Energy and Emissions Projections (BEIS, 2020)	Emissions & Generation Resource Integrated Database (EPA, 2021)
Electricity	Future Energy Scenarios 2022 (National Grid, 2022)	Emissions & Generation Resource Integrated Database (EPA, 2021)

Detailed methodology of buildings carbon analysis

Scenarios

- Each of the 4 scenarios defines the proportion of time an occupant spends at each workspace over the course of the year.
- To calculate the total emissions per worker for each scenario, annual emissions per worker for each workspace (home, city centre, and local) have been calculated.
- This has then been multiplied by the proportions in each scenario to arrive at a total carbon emissions for the stated scenarios.
- In each scenario, the offices are assumed to be sized to achieve the utilisation rates for city centre and local workspaces.

	City-centre workspace	Local workspace	Home
Traditional 5-day commuting	100%	0%	0%
Home and headquarters	50%	0%	50%
Close to home	0%	50%	50%
HQ, local workspace and home	10%	50%	40%

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