BUILDING FOR A NEW URBAN MOBILITY

Nicolas Bosetti, Joe Wills and Erica Belcher

London needs to grow its housing stock by 20 per cent over the next decade to address its chronic shortage, at a time when the rate of technological change and urgency of climate action has never been greater.

New development offers the chance to take a fresh approach to planning for mobility – one which seeks to design neighbourhoods to accommodate the needs of people over cars, which encourages neighbourliness and interaction, and enhances local and global environmental responsibility. How good is London at designing for sustainable mobility? And how can we ensure the city's new developments set the example?

This project would not have been possible without the generous support of our Funders including Supporting Sponsor, British Land and Funder, Kusuma Trust UK. We would also like to thank Hawkins\Brown for their in-kind support of this research.

CENTRE FOR LONDON

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Summary

Solving London's housing affordability and supply crises will require a sharp increase in housebuilding during the coming years. But new development will have to plug into a transport system that is already stretched – against the backdrop of a growing climate emergency.

New technologies could result in a revolution for active and shared travel, increasing the efficiency of our transport system – but it is also possible that they could worsen London's congestion, pollution and public realm difficulties by putting more vehicles on the road. One catalyst for potential problems is that many new London developments lock in car ownership and use:

- **New housing developments are more likely than existing housing to feature car parking, and their residents are more likely to own a car.** 66 per cent of residents in new London developments owned one car or more, compared to a 54 per cent London average, according to the latest available survey data published by Transport for London.

- **Many residents use cars frequently, even in areas with good access to public transport.** 30 per cent of car owners living in well-connected Inner London developments use their car most days of the week.

In response to these obstacles, this report makes the case for a policy-led approach termed "New Urban Mobility" – the harnessing of technology to enable active travel, public transport use, the cleanest vehicle technology and minimal use of private cars.

New Urban Mobility

The New Urban Mobility approach encourages use of 10 principles (emerging from research and practice) to enable adaptive and sustainable development:

1. Base masterplans on active travel and public transport
2. Use street layouts to prioritise active travel
3. Limit parking provision, and locate strategically
4. Enable easy interchanging
5. Provide electric charging infrastructure
6. Consolidate local freight
7. Offer shared mobility service memberships
8. Ensure buildings are easily adaptable
9. Future-proof parking
10. Create dynamic streetscapes

In investigating why London struggles to future-proof its new developments, we also identified five main barriers:

- Lack of priority given to planning for New Urban Mobility in planning applications.
- Lack of expertise on how to build for New Urban Mobility, with "highways" teams often focused on facilitating car movement.
- Outdated assumptions and expectations in transport plans.
- Short-term approaches to development and management, such as inflexible and incompatible construction materials and systems.
- Insufficient monitoring of new development after completion.

Recommendations

Identifying these barriers led us to form eight recommendations that will help embed New Urban Mobility in London's developments. The recommendations are focused on strengthening local political leadership, building adaptability into new developments, unbundling parking spaces from homes, and improving evaluation of progress after completion.

To strengthen local political leadership:

1. **Local authorities should prioritise New Urban Mobility in both strategic planning and development control.** This should include making sure parking provision is always compliant with London Plan standards, and where possible, even more ambitious in limiting numbers.

2. **Every London borough should designate a strategic development area as a "New Urban Mobility zone",** where they will work with developers to implement New Urban Mobility design principles (highlighted in Chapter 2) and regularly assess progress against a set of KPIs.

3. **The UK government, in partnership with the Mayor of London, should match-fund development receipts to support the development of mobility hubs in new developments.** Mobility hubs co-locate public and shared modes of transport, with added public realm enhancements. This funding would encourage boroughs and developers to implement future mobility design principles and could be achieved by growing existing funding streams such as the government's Future Mobility Zones Fund and TfL's Liveable Neighbourhoods Programme.

To build adaptability into new developments:

4. **Focus on long-term "place value".**[1] Developers and landowners should take seriously the impact that developments built with sustainable transport in mind can have on place value.

5. **Build out any barriers to adaptability.** Where car parking spaces are required, they should be built to specifications that allow easy conversion to alternative uses. For multi-storey or underground car parks, the materials used should allow future conversion to either residential, commercial or leisure use, and dimensions should be sufficient for appropriate ceiling heights.

6. **Local authorities should encourage more adaptable developments** by fast-tracking sustainable adaptations for New Urban Mobility and accommodating flexibility in discretionary standards.

To unbundle parking spaces from homes:

7. Building and estate managers should offer **renewable parking and charging membership** to residents of new developments, rather than ownership of a parking space. This would enable future conversion of residential car parks into other uses.

To improve post-completion evaluation:

8. **London boroughs, in partnership with Transport for London, should evaluate new developments once completed.** This should include evaluation of whether New Urban Mobility principles have been adopted, and collection of data on how developments are used.

Introduction

London needs to build more homes. According to the Greater London Authority's central forecast, the capital will need 660,000 new homes over the next ten years, with a large proportion of these being affordable. New homes on this scale would represent a 20 per cent increase in London's housing stock, and would in turn create demand for more schools, hospitals, shops and workplaces – along with all the infrastructure that accompanies a growing population.

However, in the rush to build more affordable homes, we must also ensure that these homes and neighbourhoods are fit for the future. A building planned in 2020 could welcome its first residents as late as 2025 or 2030 – and most buildings are designed to have a lifespan of over 50 years. Hence, we need to plan with the future in mind, at a time when the rate of technological change and urgency of climate action has never been greater.

Transport experts say that we are on the brink of a "new age" of mobility that could be as transformative as the advent of the private motorcar. Technological change has great potential to change the way we move around cities, and it is already clear that urban mobility is being reshaped by three major technological shifts – namely greater vehicle connectivity, automation, and electrification.

These innovations may well have deeper implications for how we use streets and buildings, alongside broader changes in lifestyles and working patterns. If we continue to design for the technologies and habits of the 20th century – private car ownership, a daily commute to work or school, and weekly trips to the shops – will new technology and changing habits hasten obsolescence? Or will these design and planning approaches lock in outdated and environmentally destructive behaviour?

There are other reasons why development should be designed with future mobility in mind. New developments will have to plug into an already stretched transport system. London suffers from deep inefficiencies when it comes to urban travel, at a high cost to the city's economy, society and environment.

In particular, Londoners have to deal with:

- **Long commuting times.** The average Londoner spends one and a half hours commuting to and from work every day, the longest commute of any UK region.[2]

- **Congestion.** According to INRIX, a leading US road traffic research institute, London's roads are amongst the most congested in the world.[3] Their index shows London to be more congested than Rio de Janeiro – a city of a similar population size but with a much smaller public transport offer.

- **Air pollution.** Londoners are exposed to levels of air pollution far above safety thresholds, at a very large cost to the city. Researchers at the universities of Oxford and Bath have calculated that the average car in Inner London costs society £7,700 in health-related issues arising from air pollution only.[4]

- **CO_2 emissions.** Whereas London's total "territorial" emissions have fallen by 39 per cent since peaking in 2000, emissions from transport have stubbornly flatlined – and surface transport is responsible for 75 per cent of these.[5] Both the Mayor of London and the UK government have pledged to cut territorial greenhouse gas emissions to "net zero" by 2050.

At a city level, development can either lock in efficiency or resource wastage. Researchers at the University of Berkeley, California found that within US cities, greenhouse gas emissions from households living in outlying suburbs were on average three times greater than from households living in inner city areas. This pattern was more extreme in larger cities: within the New York metro area, household CO_2 emissions specifically from transport were up to 4.5 times higher in zip codes with poor public transport access than in nearby zip codes with good public transport connections.[6] We would expect a similar pattern in London's case.

To tackle the issues of congestion, pollution and carbon emissions, Mayor Sadiq Khan has set an objective to increase the share of public transport and active travel modes (walking and cycling) from 65 per cent today to 80 per cent in 2041. However, based on the rate of progress in the last five years, our forecast indicates that London will only reach the 80 per cent target in 2070.[7]

New developments therefore represent a unique opportunity to help shift the city towards more sustainable mobility. The scale of development expected to take place in London suggests that an exemplary approach to new development could be transformative – particularly in town centres and opportunity areas where most new development will be concentrated,and with it a critical mass of investment.

Given the urgency of shifting to more sustainable transport modes, and the speed of innovation in transport, how should we go about designing London's new developments?

Research methods

This report is based on desk research, including a review of literature on future mobility and data on London's new developments. These findings are complemented by over 20 hours of research interviews with urban planners, developers, architects, mobility experts and policy leaders in local government. We used these interviews to understand how successful London is in planning future mobility into new developments, and to gather ideas for how the city can better think about mobility in the long term. Finally, architects at Hawkins\Brown modelled the feasibility of "future-proofing" what is currently a significant mobility investment for new developments: off-street parking.

Chapter 1 assesses how new technologies are likely to affect mobility in London, and makes the case for strategic thinking to shape possible mobility futures. Chapter 2 brings together the available data on London's recent developments to ascertain whether they are well prepared for New Urban Mobility, and Chapter 3 then

offers principles for how to embed thinking about future mobility in the development process. Chapter 4 reveals the main barriers to more widespread planning for future mobility, and Chapter 5 makes recommendations to developers, London boroughs and the Mayor of London on how these barriers can be overcome.

1.
New Urban Mobility

Technologists say that we are on the brink of a "new age" of mobility, which could be as transformative as the advent of the private motorcar. This new age, rather than being the product of one single innovation in transport technology, like the combustion engine was in its time, would be brought about by a combination of three technological changes: connectivity, electrification, and autonomy.

There is a lot of hype around "connected autonomous electric vehicles", and a lot of optimism around when they might come to market. Yet so much about them is still uncertain. We do not know when they might be available, whether they could cope in a city environment, and if they did, whether they would improve the city's mobility, health and quality of life.

At the same time as these technologically-driven transformations, there is a resurgence of interest in promoting public transport use, walking and cycling – forms of mobility that have lower carbon and air quality impacts than private car use, make better use of urban space, and enable healthier lifestyles and more social cities. New Urban Mobility seeks to integrate technological advances with this renewed focus on those transport modes that use the city's space and energy sparingly.

This chapter summarises recent technological developments, and the concepts underpinning New Urban Mobility, and argues that the latter should underpin the planning of London's new neighbourhoods.

Digital connectivity

Digital connectivity is making our travel more efficient in several ways. Vehicles are communicating with both each other and with the city's infrastructure, optimising route planning (for example indicating where cycles are available for hire or when the next bus is coming), or improving traffic management (for example, through real-time changes in traffic light timings). London can expect the rollout of these connected objects to continue.

Our own greater digital connectivity is also shifting our travel behaviour towards sharing a vehicle, rather than owning it. Mobile phones and apps are making

sharing vehicles a more convenient and reliable option, unlocking new business models of ride hailing, cycle or car hire. The change on London's roads is already remarkable: the number of licensed private hire vehicles operating in London has increased by nearly 80 per cent since 2008, and there are 10,000 bikes for hire from Transport for London alone.

Digital connectivity goes as deep as changing our willingness to travel: the possibilities of on-line shopping have resulted in a reduction in personal trips and a surge in goods deliveries. The smart phone is also changing the experience of navigating spaces on foot, and augmented reality navigation may alter not just our routes, but our destinations, for example as online maps help people find routes and places that are not immediately obvious to all.

Electric propulsion

As batteries become lighter and more efficient, electric propulsion could be transformative for light vehicles, greatly increasing the range and speed of scooters and bicycles, compared to their human-powered equivalents (though safety concerns mean that electric scooters are not currently permitted on TfL roads and pavements).

Progress in battery technologies is also rapidly enhancing the performance of electric propulsion for heavier vehicles, enabling greater range,a shorter charging time and large energy savings. So far "range anxiety" has been an issue, though less so in cities, but increasing battery capacity and charging availability should help tackle this.

At present, electric vehicles are still more expensive than traditional cars powered by internal combustion engines, and although this premium can be made up over a number of years through cheaper operating costs, the upfront outlay still represents a barrier to electric vehicles taking off.[8] However, the point at which electric vehicles will become cost-competitive is rapidly approaching, and should change the market for cars substantially.[9]

Vehicle autonomy

Technology enabling vehicles to self-drive to destinations in controlled environments is available and progressing

fast. Improvements in sensors, machine learning, mapping, and connectivity are allowing vehicles to take on more of their drivers' responsibilities, and navigate messier urban environments.

Whilst technology companies predict that drivers will become superfluous (full automation in the table below), some transport experts and urbanists question whether this will be safe, or possible in urban environments where narrow streets and sharing with pedestrians, cyclists and non-autonomous vehicles is the norm.[10]

Table 1: Levels of autonomy

Level	Name	Description
0	No autonomy	Human required for all tasks and must monitor road at all times.
1	Driver assistance	Computer assistance for either steering or speed control. Human work and monitoring essential.
2	Partial autonomy	Steering and speed controlled by Advanced Driver System in defined use cases. Human monitoring essential at all times.
3	Conditional autonomy	"Automated Driving Systems", with vehicle monitoring environment to make decisions. Human control available to intervene, for example, in adverse weather conditions.
4	High autonomy	All safety-critical driving functions are automated within Operation Design Domain (ODD). The technology is applicable to driverless shuttles operating in private or managed environments such as worksites.
5	Full autonomy	Vehicle requires no driver either for tasks or monitoring environment, in any domain.

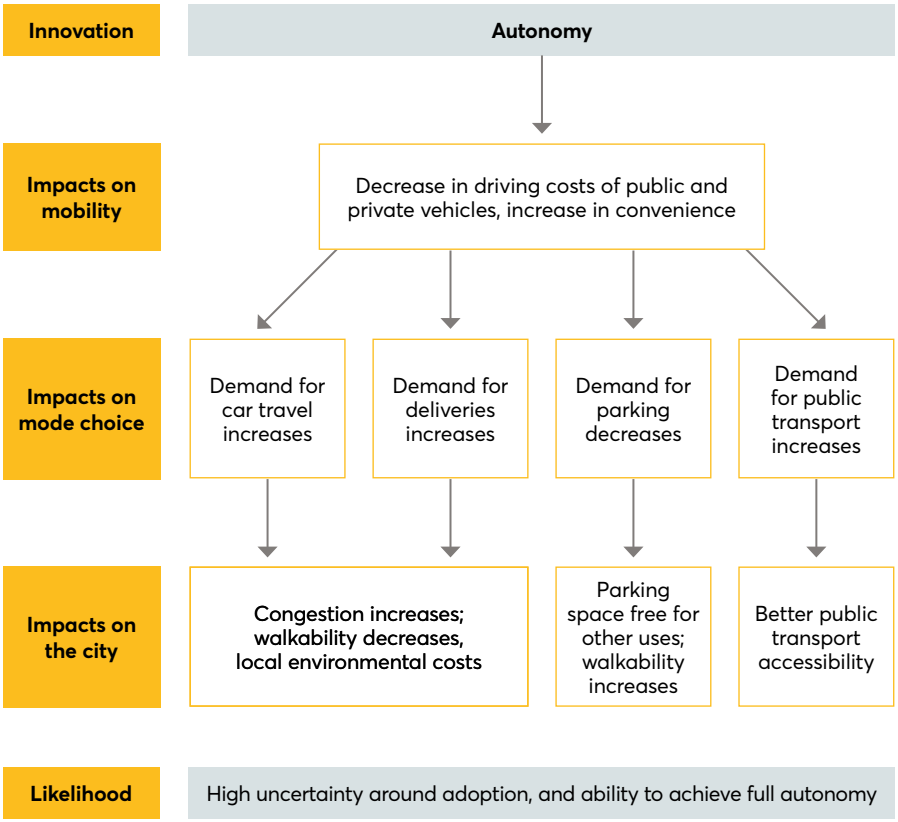
Source: Adapted from Society of Automotive Engineers, (2018).[11]

The contradictions of future mobility technologies

Combined, electrification, automation and greater connectivity could drastically reduce the cost of both personal and goods transport. In a scenario where full autonomy is achievable, connected autonomous vehicles would not require a driver or parking space, could operate 24/7, and could potentially benefit from lower energy costs.[12] In theory, this could yield very large efficiency gains – in the form of time savings or improved accessibility, and environmental benefits, from reduced tailpipe emissions and energy savings.

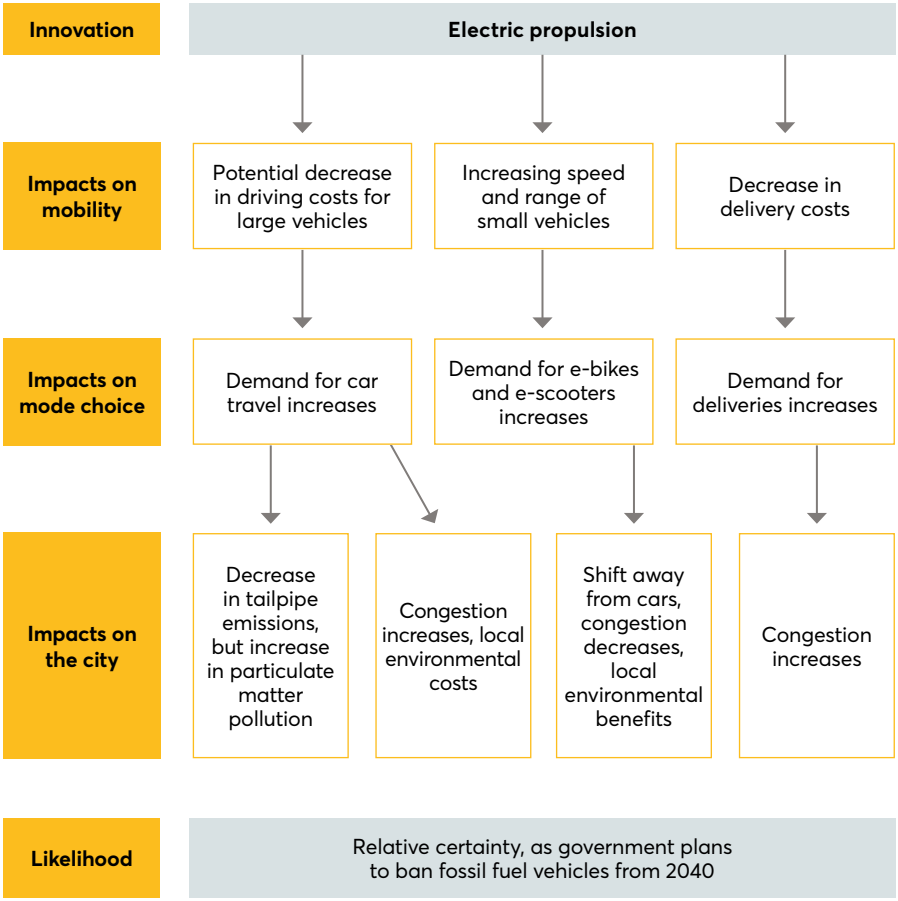
However, when transport costs fall, demand often rises. A new rush to private transport for people and goods would increase congestion on roads and air pollution from sources such as brake dust and tyres – thus cancelling some or most of the benefits of autonomous vehicles. Figures 1a-1c summarise some of the likely impacts of these technological changes in mobility, and shows that they can be diametrically opposed. Predicting outcomes would depend on many assumptions - around availability, adoption and policy environment.

Figure 1a: Possible urban outcomes from autonomy



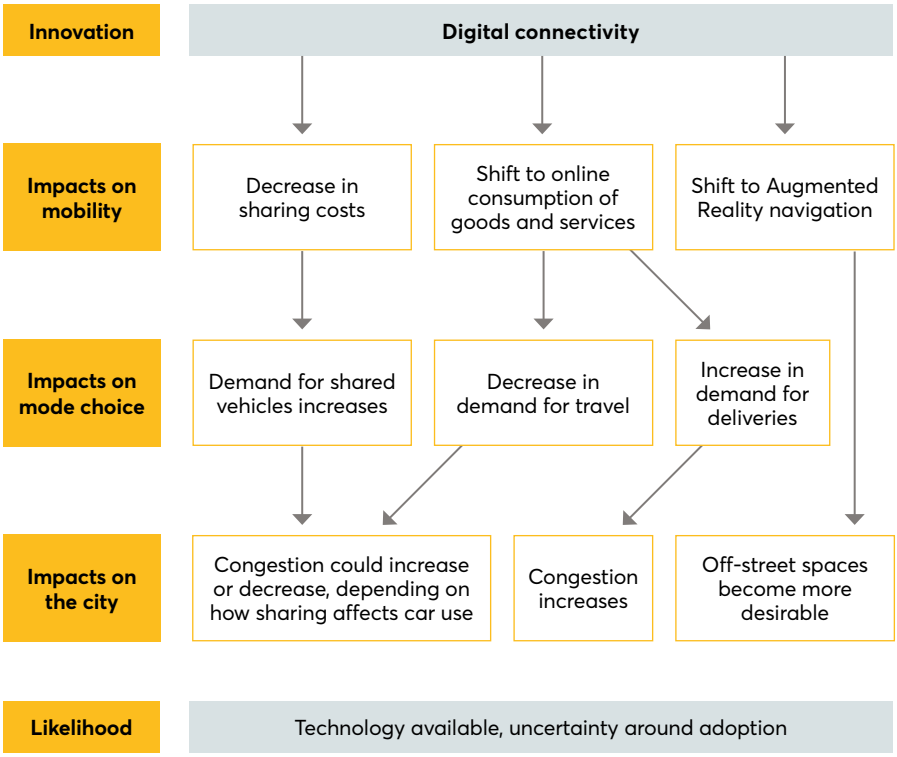
Source: Authors' interpretation of McKinsey (2019) and Government Office for Science (2019).[13]

Figure 1b: Possible urban outcomes from electric propulsion



Source: Authors' interpretation of McKinsey (2019) and Government Office for Science (2019).[13]

Figure 1c: Possible urban outcomes from digital connectivity



Source: Authors' interpretation of McKinsey (2019) and Government Office for Science (2019).[13]

On top of this, a technology's availability does not mean it will catch on: whether people trust self-driving technology and are able or willing to pay a premium for it is key. In turn, adoption of new transport technologies depends on investment in the systems that support them. Rolling out connected electric vehicles requires installing adequate charging and data infrastructure, as well as considerable investment in energy production: the National Grid estimates that under scenarios of widespread electric vehicle adoption, peak energy demand in 2050 would be 30 per cent higher than today.[14]

Introducing New Urban Mobility

While there is relative consensus on what technologies could change travel, there is much less agreement on the timing of their adoption, or how widespread use would play out in cities.

Concurrently with technological advance, there has been a significant shift in how policy experts think about mobility within towns and cities. This approach – which we and others call "New Urban Mobility" – arises from a number of sources, including the work of the UK's Urban Task Force. It is partly a response to the mounting climate crisis and the contribution of road transport to carbon emissions and air pollution – as well as the socially alienating effects of late 20th-century car-based urban planning, which produced city sprawl and leached life from town centres. It also addresses public health concerns such as the growing levels of obesity that arise partly from inactive lifestyles.

New Urban Mobility seeks to harness new technology that will enable cities to grow while minimising the need for car-based transport and maximising the potential of walking, cycling and public transport use. It seeks to design cities and neighbourhoods to accommodate the needs of people over cars, to encourage neighbourliness and interaction, and to enhance local and global environmental responsibility.

New Urban Mobility also meets urgent challenges facing London in the 21st Century, through being:

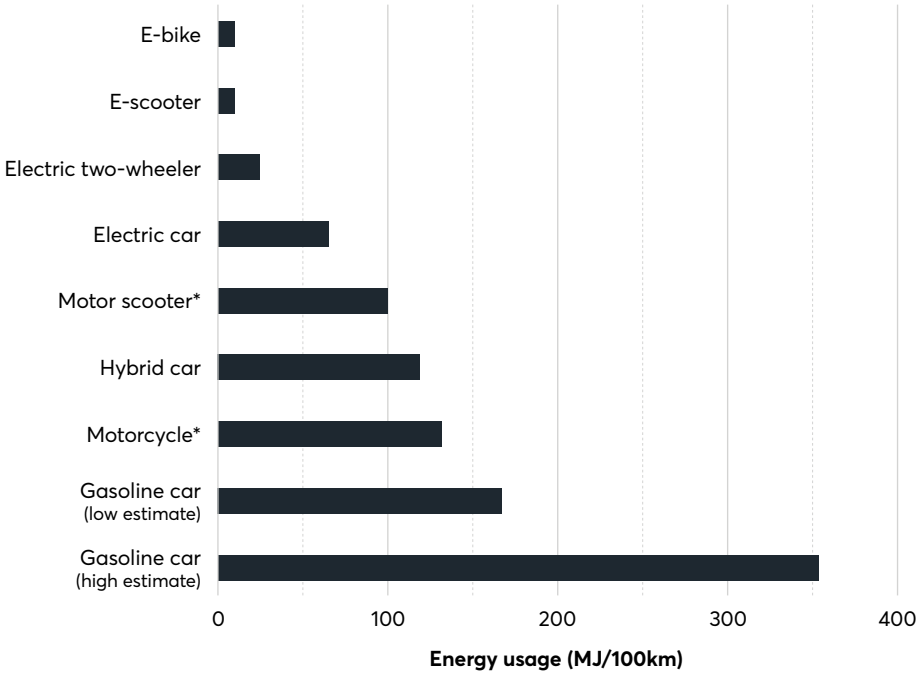
1. **Less energy intensive.** London is dense, and therefore favours public transport and shared mobility systems: trains and buses, ride hailing and bike sharing are all much cheaper to operate in urban environments, where many people need to travel along similar routes. Density also allows for shorter travel distances, and more local service provision, which make walking or cycling trips possible.

2. **Less space hungry.** Density also creates constraints: space is valuable, and cities are always short of it. Most of the city's public realm is taken up by roadways, which could be allocated to alternative uses, from walking and play spaces.

It is within this framework that we should be analysing the potential benefits and costs of new mobility technologies, and how we should be designing for them. This implies that developers and local authorities should not just seek to maximise flexibility in new developments so that they can serve any kind of future mobility, but instead focus on the outcomes they want to see – namely shorter, more reliable and less carbon-intensive journeys, as well as less air pollution.

New Urban Mobility, centred around walking, cycling, public transport, and light electric vehicles, should therefore be at the heart of planning new neighbourhoods. For heavier vehicles, electric vehicles offer greater energy efficiency and lower emissions than petrol or diesel, and – where individual transport is needed – shared and rented, rather than individually owned, vehicles will be preferable. The relative energy efficiency of private vehicles is highlighted in Figure 2.

Figure 2: Energy usage by vehicle type



*Energy used based on one model, recognised as an average.

Source: Yanocha D., Allan M. (2019). The electric assist: leveraging e-bikes and e-scooters for more liveable cities. Institute for Transportation & Development Policy

In a planning system that links density with transport, facilitating New Urban Mobility could also yield fresh development opportunities. Replacing some of the larger private vehicles on London's streets with smaller vehicles such as bikes would not only curb congestion and pollution, it could also increase road capacity, as smaller vehicles offer greater throughput. By increasing connectivity, New Urban Mobility could also increase development potential in areas previously held back by constrained transport capacity, and free streets and building sites from domination by parked cars, thereby releasing land for new buildings or public realm.

The next chapter looks back at recent developments in London, to assess whether they are friendly to New Urban Mobility.

2.
A snapshot of new development

Two decades of mayoral policies aimed at focusing denser development nearer public transport hubs have produced new developments that are mostly compact and well connected. Despite this, residents in new developments are more likely to own a car, more likely to use it frequently, and have access to more off-street parking than people living in London's older housing.

This chapter brings together the best available evidence on London's recent developments – to ascertain whether they are well prepared for New Urban Mobility, or simply locking in 20th-century urban transport patterns.

Density

In every single year since 2006, less than seven per cent of developments approved across London have had densities below the London Plan's expectations, which have been set according to urban form and public transport accessibility levels (PTAL). Instead, developers have been seeking to maximise value by building denser than is recommended in the Plan, as shown in Table 2.

Connectivity

London's new developments are better served by public transport than the existing housing stock – particularly private market housing, which is twice as likely to be located in a high-connectivity area than the city's existing housing stock.

London's new affordable housing units have lower public transport accessibility on average than new market housing, but are still better served by public transport than London's existing housing stock. Figure 3 compares the public transport accessibility of new developments, completed since 2012, and pre-existing housing.

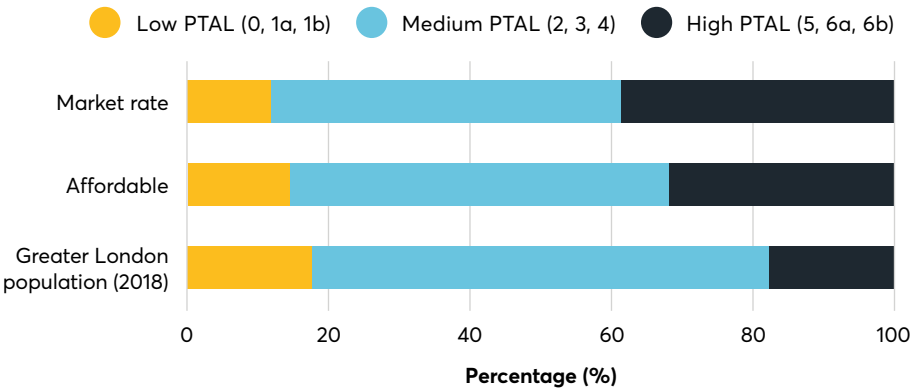
As highlighted in the previous chapter, and in Centre for London's 2019 *Fair Access: Towards a transport system for everyone* report, it is crucial that new employment is located in places that are well connected to public transport.[17] This is also a strategic matter for London, since the city created 1.1 million jobs since 2006.

Table 2: Residential approvals compared to the density matrix

	% of units approved		
Financial year	**Within density range**	**Above density range**	**Below density range**
2006/07	39%	57%	5%
2007/08	25%	71%	3%
2008/09	35%	60%	5%
2009/10	36%	59%	5%
2010/11	45%	52%	4%
2011/12	37%	58%	4%
2012/13	45%	51%	4%
2013/14	39%	55%	6%
2014/15	32%	61%	7%
2015/16	52%	44%	4%
2016/17	43%	51%	6%
2017/18	35%	59%	6%

Source: Greater London Authority, London Plan Annual Monitoring Report 2019.[15]

Figure 3: New development by Public Transport Accessibility Level (PTAL)

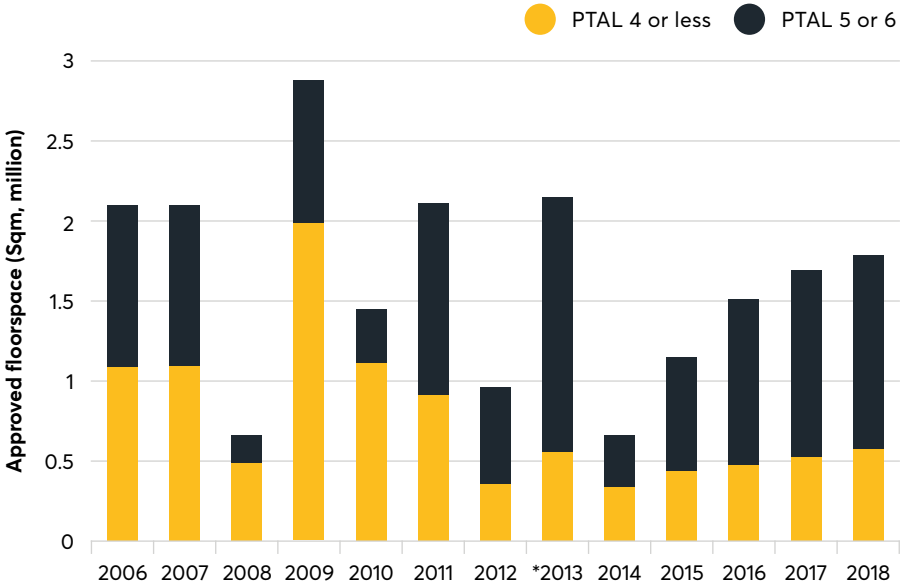


Net completed housing units between 2012 and 2019.

Source: London Development Database (LDD) net housing units, 2012 to 2019 by Public Transport Accessibility Level (PTAL)[16]

Most new commercial floorspace delivered in recent years has been in areas that are well connected, but this is a recent trend. Between 2006 and 2010, only one-third of new commercial space was located in areas of high PTAL; since 2011 this has risen to two-thirds, as shown in Figure 4. We expect that forces of economic agglomeration, planning policies favouring density, and strengthening opposition to "out-of-town" retail have contributed to this shift.

Figure 4: Approved commercial floorspace by Public Transport Accessibility Level (PTAL)



*2013 excludes Olympic site

Source: Greater London Authority, London Plan, Annual Monitoring Report 2019.[18]

Investment in mobility

Beyond the location of what is built, development shapes future mobility through the investment it generates. Every substantial development invests in mobility – whether it is new parking space for cars or bicycles, public realm improvements such as new walking routes, or contributions to public transport upgrades. But

what sort of transport investments have been made by new developments?

We know little on how developer contributions are spent but we do know that developer contributions will make up around five per cent of funding for Crossrail one and 25 per cent of funding for the Northern Line extension to Battersea (with future tax revenues from the development expected to contribute the remaining 75 per cent).

However, London developments also make major investments in enabling car travel. A case in point is the Battersea Power Station development, permitted in 2013, which will have a car parking ratio of 0.43 spaces per new residential unit, above the maximum of 0.25 recommended by the Opportunity Area Planning Framework. The development will also provide 1,500 car parking spaces for non-residential uses, despite its location on the future Northern Line extension.[19]

This is not an isolated example: overall, new developments have been making generous investments in car parking. Comprehensive evidence for this comes from a large postal survey undertaken by Transport for London in 2011 on car parking provision in new developments, which gathered 3,022 responses from residents living in 839 new developments across the capital and was weighted to be representative of residents living in all new developments.[20] Given residential parking standards were only overhauled in 2018, we expect the 2011 survey to be representative of new developments until very recently.

The survey revealed that residents of new developments were more likely to have off-street parking than people living in existing housing stock, despite the shift towards apartment buildings. 33 per cent of respondents lived in developments with more than one parking space per unit, and a further 48 per cent lived in developments with between 0.5 and one parking spaces per unit.

Despite having better public transport access than average, residents of new developments are more likely to own a car than the general population. They are also more likely to have more than one car, as Figure 5 shows:

Figure 5: Household car ownership, 2011

Source: TfL, Residential Parking Provision in New Developments[21] & Roads Task Force Technical Note 12.[22]

Regardless of public transport accessibility, where parking provision in new developments was generous (at least one parking space per unit), car ownership was also high – running at 75 to 80 per cent of residents.[23]

Of course, there are also model developments when it comes to car parking. A senior transport planner at Transport for London noted a recent increase in the number of "car free" developments in the inner city – that is, developments with no car parking provided, and where residents cannot obtain long-term on-street parking permits, in conformity with the new parking standards introduced in the draft London Plan.[24] This change is welcome, but the challenge of implementing less car-reliant forms of development in outer London is likely to remain a serious one.

Bicycle parking, on the other hand, is rarely provided with the same generosity. A 2016 monitoring survey of 71 new developments in west London conducted by WestTrans found that 45 per cent of the "bike parks" promised by developers were missing, and that none of those provided were user-friendly: for instance, many required cyclists to lift their bike up a steep ramp or to go through narrow doorways.

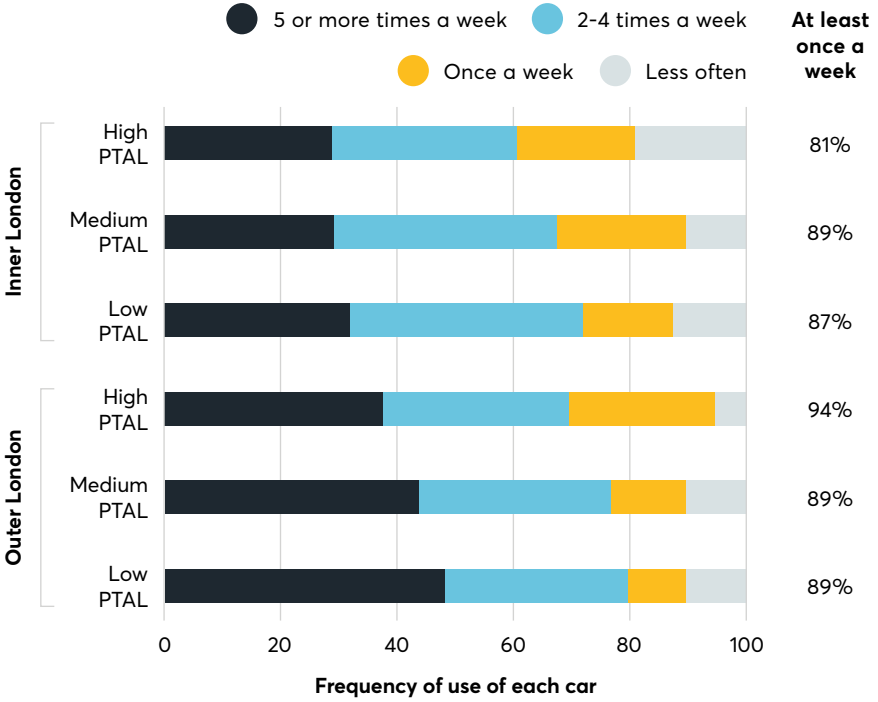
Trips generated by new developments

We know less about how residents of new developments move around the city, but the aforementioned 2011 TfL survey again sheds some light on car journeys made by this population. Not all car owners living in new developments use their car frequently, but the majority do – even in the best-connected parts of Inner London for public transport. 60 per cent of car owners living in well-connected Inner London developments use their car at least twice a week, and 30 per cent use it most days. In both Inner and Outer London, frequent car users say that they are on the road at peak times.

So although London's new developments are more compact and better served by public transport than the city's older housing stock, they are also more accommodating in terms of car parking, and often not very bike-friendly. Additionally, residents living in new developments are more likely to own a car, and the majority of car owners use it several times a week – regardless of public transport accessibility.

Rather than preparing for New Urban Mobility, developers and planners are locking citizens into 20th-century patterns of car ownership and use by allocating space and investment to private car parking spaces.

Figure 6: Frequency of car use by car owners in new developments, 2011



Source: TfL, Residential Parking Provision in New Developments.[25]

3.
Design principles

Influence behaviour

When we plan and design cities, we set expectations for behaviours and attitudes. From the mix of uses to the quality of transport connections, decisions taken in the early stages of development shape our travel choices much further down the line. This chapter offers principles on how to plan and design for New Urban Mobility, drawing on our interviews and literature review.

Design principle 1:

Base masterplans on active travel and public transport

Planning land use, street layouts and the location of services in order to promote walking and public transport use can lead to a large increase in the mode share of active and collective travel. A comprehensive analysis of 50 studies measuring the effect of the built environment on travel behaviour identified the built environment characteristics that have the biggest impact on walking and public transport use:

- Land use diversity, street and intersection density, distance to the nearest shop, and distance to employment space have been proven to strongly increase walking.
- Distance to a public transport stop as well as street and intersection density generate an increase in public transport use.[26]

This means that by giving pedestrians and bicycles the most direct access routes through a neighbourhood, and providing a walkable mix of uses, masterplanners can help increase the preference for active travel over car travel for short trips.

Design principle 2:

Use street layouts that prioritise active travel

Designing the public realm to make active travel the most convenient and safe option can also yield significant increases in walking and cycling. Examples of features that prioritise active transport modes include:

- **Street design.** Narrow streets which slow down vehicular traffic; vulnerable road users such as cyclists; and "shared spaces" where traffic mixes at very slow speeds. Transport for London offers guidance on which road design features can best achieve these objectives.[27]
- **Access.** Giving pedestrians and bicycles the most direct access from their home to the street – for instance, by locating bicycle parking at the front entrance of buildings, or building slightly wider hallways to facilitate bicycle deliveries – could greatly improve the convenience of active travel journeys.
- **Traffic management systems.** For instance, traffic lights that limit vehicular throughput within a neighbourhood and help control the buildup of traffic within a residential area; or "green wave" traffic lights phasings that reduce waiting times for cyclists by letting them catch the green lights.

Design principle 3:

Limit car parking provision, and locate strategically

The availability and cost of parking encourages car ownership, which in turn encourages car use. The new London Plan takes note of this, and requires developments in areas of high Public Transport Accessibility Levels to be car free, most of which are in inner London.

In the outer suburbs, where there is higher reliance on the private car, and car parking provision is necessary, the location of car parking can help reduce car use. A survey of the travel behaviour of 2,439 urban residents in Norway shows that a slight increase in the distance of home parking has a large impact on car use. Researchers found that having to walk 50 metres to one's car led one in three car users to choose an alternative mode for shopping and service-related trips. The survey also found that most urban dwellers were happy to walk further to their home parking spot – 155 metres on average.

This suggests that parking and housing do not need to be located on the same plot of land, and that a modest separation would lead to lower levels of car use.[28] In the short term, this would release land that would otherwise be dedicated to on-site or on-street parking; in the long term, off-street parking facilities could more easily be adapted to other uses than individual parking spaces.

Design principle 4:

Facilitate interchanging

Easy interchanging between modes of transport is key to competing with the convenience of door-to-door car journeys. One way of doing this is to create "mobility hubs" by co-locating public and shared modes of transport, with public realm enhancements. Mobility hubs would include space for car, bike and taxi hire or drop-off, interchanging from rail or bus to a local shuttle, and parcel pick-up stations.

Guidance from shared mobility advocate CoMoUK recommends that these mobility hubs should be designed to be comfortable and visible from nearby streets, and should include amenities such as wide pedestrian pavements, covered waiting spaces, public parklets, manned convenience stalls for snacks (which also provide a sense of security), and travel information.[29]

To facilitate interchanging, developers should provide and safeguard generous public space for transport hubs. According to one architect interviewee:

> "A lot of the issues we come across are around safeguarding space. We find a lot of developers who are wanting to build denser and closer to stations, and we need to make sure we still safeguard space for the mobility that might come in the future."
> **Architect**

Design principle 5:

Provide electric charging infrastructure

Where off-street parking is provided, it will need to be equipped with electric vehicle charging infrastructure in order to make residual car trips less carbon-hungry and less polluting. The charging hardware should be robust, and should allow for dynamic pricing, to encourage charging at off-peak times. In 2019, the government consulted on mandating that "every new residential building with an associated car parking space should have a chargepoint."[30] Locating any car parking off-street should make it more cost-effective to install charging infrastructure, and avoid clutter in the public realm.

Design principle 6:

Consolidate local freight needs

Van traffic in London is up nearly 30 per cent since 2012,[31] but much of the "last mile" traffic through neighbourhoods could be reduced by consolidating deliveries to a single neighbourhood location. New neighbourhoods should have local distribution centres or shared pick-up zones to reduce the number of freight trips into and around the neighbourhood. These could be integrated with local shops – supporting local retail – and could also facilitate smaller vehicles for last mile delivery, such as cargo bikes. Consolidation centres should also have electric charging provision designed in.

Design principle 7:

Offer shared mobility service memberships

In the long term, developments should aim to minimise car use. In the meantime, however, they should enable access to car clubs for trips where active mode or public transport is impractical. In London, car club membership offers "just when you need it" car or van hire by the hour. They are proven to reduce car use among their members who used to own a car, and can be more affordable too, depending on miles driven.[32] For convenience, these vehicles should be parked at the development – for example in the shared mobility hub – and should also be electric, to reduce local air pollution.

Mobility service memberships should include reliable and affordable emergency rides. The decision to own a car can be skewed by the perceived need to deal with rare or unlikely events – for example an urgent trip to hospital, or an occasional cross-country trip with limited charging infrastructure. Offering an emergency ride service or nearby car rental for long-distance drives is the kind of intervention developers could make that would enable their residents to adopt car-light lifestyles.

Build in adaptability

Whilst design can prioritise some forms of travel over others, new developments must retain the ability to evolve with the needs of its residents. But although there are many design guidelines available to encourage active and sustainable travel – including Transport for London's Healthy Streets Toolkit, NHS Healthy New Town Principles, and the Cambridge Quality Charter – our research has found that few embed adaptable design in their guidance. Our interviews also indicate that few resources are directed towards flexible planning and design to accommodate future mobility. The following principles are aimed at filling this gap.

Design principle 8:

Ensure buildings are easily adaptable

Given the speed of technological change, there is always the possibility for some unforeseen innovation to further change the way we move around cities. The question is: how can buildings respond to such potential changes?

Ensuring they are flexible enough to respond is key. Configuring space in an adaptable way that ensures easy access to services can greatly reduce retrofit cost – as does using construction systems that are interoperable and which do not involve over-reliance on limited suppliers. Yet several interviewees told us that this was not common practice:

> "For me flexibility is about how undoable things are. How easy are things to take apart? A lot of current systems are patented systems […]. This makes the new tech harder to edit than older tech (i.e. brick walls and timber stud construction). We should be designing for disassembly, and have contracts and warranties that make it easy to change things further down the line."
> **Head of Planning, London borough**

Design principle 9:

Future-proof parking

Currently, one of the biggest investments that developers make to provide for future mobility is car parking provision. Although the new London Plan lowers maximum parking standards across the capital, many developments will continue to require some parking space, with great uncertainty as to whether the space will be needed in the future. What if designs for active travel shift residents' preferences, or driverless pods provide quick and reliable access to a new station a mile away, making car ownership practically superfluous? Can London's new neighbourhoods provide space for parking that evolves with future mobility needs, and helps to change behaviour, while meeting today's requirements?

We were told by a senior urban designer that future-proofing for mobility can unlock great value in the long term:

> "There is a general assumption that we should be perfecting the design, but really completion is just the start of the design process, which then changes the building through its use. The more successful development products are the ones that can evolve. 1930s suburbs contain latent adaptability. The front gardens of London's suburban houses have become driveways for private cars, and we could reuse the wide roads designed for the automobile to create generous cycle lanes and space for a new generation of collective transport."
> **Head of Planning, London borough**

Ideally, as discussed in Principle 3 above, car parking should be located away from residential development, to encourage alternatives to car use and enable conversion to other uses over time. Where parking is provided on or near the site, the potential for conversion should also be maximised. Where parking is built in a basement, introducing light wells, open structures and slightly higher ceilings could make these spaces as flexible as London's railway arches. Alternatively, spaces could be provided in a shared facility that could later be used for development if demand fell away – for example, a parking lot or multi-storey facility (contd).

Where surface parking is provided on-street, it could be designed to retain development potential. Some car parking spaces could be used for storing and servicing autonomous vehicles, or storing electric bikes and scooters so they do not clog street pavements. Other spaces could be used as light industrial, makerspaces or commercial units.

Architects Hawkins\Brown have produced a proof of concept for convertible off-street parking. The drawings, presented in the annexe, are based on a recent London development, and show how developments that must provide off-street parking for today's residents can easily facilitate the shift to New Urban Mobility.

Design principle 10:

Create dynamic streetscapes

Pressures on roads and streets vary by time and day of week. A more dynamic approach to roads and streets could help accommodate changes in travel demand, and even gradually incentivise behaviour change. Such an approach could range from low-tech/low-cost changes like varying circulation or parking rules depending on time or day, through to more extensive physical interventions.

At the "low cost" end of the spectrum, loading and other vehicular access could take place at times where pedestrian and cyclist demand is low, in order to keep traffic segregated. This could take place at existing dedicated locations or via virtual loading bays, in order to respond more flexibly to changing needs.

Innovation in mechanical furniture also means that streetscapes can adapt to demand at different times of day or at the weekend. Platforms such as Arup's "FlexKerb" can enable lanes and kerbsides to change function throughout the day and week in response to user demand. Arup describes its potential as follows:

> "FlexKerb could offer an extra-wide footway during peak commuting hours. Late at night or after the morning rush, FlexKerbs could open up extra space for freight activity to meet policy objectives around off-peak deliveries. On weekends, local businesses could reserve pedestrianised stretches of kerb for street festivals or outdoor vending, supporting objectives around the activation of public space. Meanwhile, throughout the day and week, the FlexKerb could maintain a variable length of kerb for the exclusive use of connected and autonomous vehicles (CAVs) to ensure they have safe and non-obstructive places for passengers to board and alight."[33]

Arup also expects that the investment could be recouped by renting out kerb space – as users could reserve a space for parking and loading.[34]

On the question of adaptable public realm, one interviewee noted:

> "We're very good at implementing flexibility for security concerns – hostile vehicles, fire prevention. We've got mechanical bollards, breakable road surfaces for vehicles that are too heavy. So we can create a public realm that is adaptable, but you don't see a bench that pops out on a Sunday anywhere even if the technology exists for security purposes."
> **Senior urban design consultant**

Other examples of user prioritisation could include LED road markings that adapt to traffic circumstances – for instance to widen crossings or allow more time for pedestrians at peak hours.[35]

These principles are designed to enable a policy-led transition to New Urban Mobility in London's new neighbourhoods. In Chapter 4 we consider the barriers to their adoption.

4.
Barriers to New Urban Mobility

On the whole, the development and planning process has not had great success in making and managing urban places in accordance with the principles of flexibility and sustainability outlined above. Our research indicates that the principal barriers arise from:

- The planning process.
- Different approaches to development and management.
- Construction materials and systems.

The planning process

Balancing priorities and viability

The "nuts and bolts" of the planning process and development control can hamper the delivery of developments that enable New Urban Mobility.

The UK planning system requires contributions to infrastructure to be negotiated on a site-by-site basis. Balancing policy requirements at a local level while not impacting viability, in line with the National Planning Policy Framework, means that trade-offs are inevitable. For example, the amount of green space, the number of units, rights to daylight, and provision of community facilities could all be in tension with each other. Considerations that affect transport and mobility are no exception. For example: creating cycle parking or doorways that can accommodate e-cargo bikes will have space implications – and will therefore require balancing against other policy goals.

Relative policy and political priorities become important here. The overriding pressure to meet annual housing targets could squeeze provision for New Urban Mobility. The ability to deliver both depends on the capacity of planning departments, but also on political will and leadership. This can in turn reflect local attitudes towards mobility. Deep-seated cultural attachments to car ownership, electoral concerns of politicians and uncertainty about local public

transport improvements all combine to mitigate against concerted action on sustainable transport. During our research, we have heard of developments providing the maximum parking spaces as a default in order to "get through planning", rather than pushing for more ambitious targets.

Professional specialisms, inputs and standards

Planners' and politicians' ability to consider transport assessments and advocate for more sustainable options can be limited by professional specialisms. In addition to a traditional disciplinary split between "Transport" and "Planning", research has identified that where planning departments have in-house transport specialists to support the development management process, they typically come from a traffic and highways background. This means they can exhibit a bias towards traffic flow considerations and may lack knowledge of other sustainability options.[36]

However, without advisors to understand and advocate for sustainable options, their adoption is often limited. Similarly, having detailed input from operators on the cost of different sustainable transport interventions, sufficiently early in the planning process, could help ensure they are factored into deliberations. However, research has shown that this frequently fails to occur, and when it does, it can come too late in the process to be meaningful.[37]

Many interviewees also expressed concern about whether the standards specified for "adopted" local authority roads were compatible with innovative approaches such as "FlexKerb" or "shared space" approaches to street design. A senior planning officer told us:

> "Most people who work in highways in local authorities know about roads, that's their background. They know about how to serve private motor vehicles, so the culture is more about sustaining flows of traffic, rather than evolving and changing our transport culture."

Assumptions and predictions

One of the fundamental tasks of planning for mobility in new developments is the transport assessment process. Developers are required to plan for the amount of movement generated by the development. This involves attempting to model the new number of trips and their modal split. Typically, models use standardised assumptions about the mode share and number of trips generated for each type of development, which are supplemented or adjusted to more accurately reflect local conditions.

However, these assumptions can be based on site surveys done several years ago, and as such will not reflect any recent changes or innovations in mobility, let alone future policy aspirations. In theory, professional judgement can rectify the problem, but this can also be based on outdated assumptions and analysis.

It is possible to obtain more accurate and up-to-date assessments of current trends in mobility by commissioning bespoke surveys. But this is expensive, and therefore less likely to be developers' first choice. Even where metrics for determining transport provision at a site are accurate and established – as PTAL is – our research participants suggested that the metric itself may be flawed, as it demonstrates a general level of public transport accessibility rather than an indication of where people will likely travel to and from.

Similarly, for large sites subject to multiple planning applications, initial transport assessments can become dated even over the course of the build-out. For instance, at Barking Riverside, a development site of citywide importance, planning permissions are being granted based on transport assumptions and modelling from 2004.[38]

With limited resources and skills, it can be hard for local planning authorities to push for better evidence and to interrogate the assessments provided. Spending on planning and development services across local authorities in London has been reduced by just under 50 per cent in the period 2010-2018.[39] Reductions in budgets are impacting staff retention, experience,

quality and departmental capacity.[40] Undoubtedly this presents a challenge for planning departments wishing to create and shape high-quality places.

Survey evidence from borough planning departments in London illustrates how this is playing out on the ground. While development management is still relatively well resourced, planning policy, transport, parks, open space and public realm are all underserved, with some specialisms like public realm having shrunk by 75 per cent on average per department in recent years.[41] The level of capacity is not aligned with the levels of growth targeted for each borough, and a number of authorities have no in-house expertise in landscape architecture, public realm or development economics.

Development and management

Monitoring post-occupancy needs and changes

Good buildings can respond to changing circumstances: what is needed today may be redundant in the future, and what is needed in future may be unknown today. For instance, if there were improvements to local public transport provision several years after completion of a new development, this could allow for removal of car parking spaces. On-street car parking could be transformed into alternative amenity uses, such as cycle parking, parklets, or sustainable urban drainage systems. Similarly, basement and podium parking – if built to appropriate specifications – could be repurposed for leisure or commercial uses, which could then provide an income stream.

However, this process of evolution requires a mechanism for monitoring and responding to change. Typically, alongside transport plans for movement of people, planning applications for mixed-use developments require a servicing strategy to set out how movement of goods onto a site can be as efficient and sustainable as possible.

In theory, these documents should be live plans that respond to changes in service provision and citizen behaviour. But in practice, monitoring and updating

seems limited. At present, there is no regulatory requirement for landowners and managers to review the way that their developments are operating. This limits scope for ensuring adaptation and retrofitting in future. Without targeted incentives or mechanisms to guarantee it, future-proofing becomes dependent on the good will, or enlightened self-interest, of landowners.

Short-termism and absenteeism

Who owns, develops and manages new developments can impact on how well equipped they are to adapt to New Urban Mobility. The economics of different development models, the specialisms of different developers, the different interests in management of the land and the tenant mix will all have an impact.

Developers building for sale may not be interested in sustainable infrastructure that could require more hands-on management, or which is not yet "standard" and thus may not be popular with customers. For example, having flexible loading bays needs both a well-managed delivery and servicing strategy, as well as careful treatment of materials. Implementing such a plan might load costs onto the developer, as well as potentially limiting the range of potential occupiers/buyers, so this is unlikely to be considered unless stipulated as a planning condition.

In the absence of a long-term view or interest in a development, the same kind of business model might also mean less attention is paid to "place value".[42]

> "We know the value of a river view, because we've been able to compare sales for 25 years. But we don't know the value of an ethical property."
>
> **Commercial Developer**

Analyses of the relationship between property values and urban design demonstrate strong links between mixed-use, walkable, permeable neighbourhoods that are not dominated by cars and have good access to public transport, and increased property values.[43] This is in addition to wider social benefits such as reduced air

pollution, lower incidence of obesity and asthma, and enhanced quality of life.[44]

The other side of this equation can be a distant landlord or operator. Hands-off or inaccessible management can restrict how well developments are able to adapt to meet new mobility requirements. We heard examples of property managers being unable and unwilling to make changes to materials in response to fire safety concerns. In the words of an interviewee: "If some landowners won't even do that, how can we hope for them to make other, less urgent changes?" A distant landlord with a hands-off business model is unlikely to enable adaption to New Urban Mobility.

Construction materials and systems

Building in permanence

The essence of adaptability is leaving enough "wiggle room" to accommodate change. This applies at all scales of construction – from the strategic level down to discrete components. Our cities are full of instances where this has failed in the past. Building inner-city roads to prioritise cars is the classic example – creating heavy concrete infrastructure that dominates its surroundings and is expensive and difficult to undo.

The same applies for building systems for dwellings. The problem can be purely practical – for example, having services too deeply embedded to change easily, or having structural components that do not allow for internal reconfigurations. Adaptable buildings allow for systems to change quickly – and especially those layers that have a shorter lifecycle than the shell and therefore will need to be changed. Table 3, adapted from theorist Stewart Brand, offers a conceptual framework for designing in adaptability.

Table 3: Building layers

Site	Geographic setting of building	Eternal
Structure	The loadbearing elements including foundations	30 to 300 years
Skin	The exterior surfaces providing the weather protecting layer	20 years
Services	The working guts of the building — heating and ventilation (HVAC), electrical, plumbing, sprinklers, cabling etc	7-15 years
Space plan	The interior layout —internal partitions, doors, etc	3-30 years
Stuff	Furniture, equipment, personal positions of occupants	Daily

Source: After Stewart Brand (1994), How Buildings Learn, cited in Gorgolowski (2005).[45]

Interviewees noted that adaptive design is often viewed unfavourably because it is conflated with a lack of precision.

> "The latest technology becomes outdated very quickly and there's always a requirement to go back and edit. But developers, architects and planners are often reluctant to say that what they're doing isn't right the first time as to them it sounds like an admission of failure [...] we need to build in more tolerance."
> **Head of Planning, London Borough**

To put it simply, flexible design is not being widely adopted because the idea of adapting developments after they have been built is believed to reflect negatively on the architect/developer/builder, whose design lacks sufficient rigour to "get it right" the first time. This mindset needs to change.

There are also barriers to adaptation related to ownership of construction technologies, and their interoperability. Over-reliance on bespoke, patented

technologies means that changing them involves relying on smaller numbers of suppliers. This could involve higher costs – or in the long run, the risk that the supplier is no longer operating. One research participant contrasted this situation with older materials such as timber stud and brick, which are argued to be much more "democratic" because the technologies can be easily adopted by different users. Centre for London has previously recommended a common design framework to enable standardisation and interoperability for new construction methods.[46]

5.
Recommendations

This report has argued for a change in the way we carry out development in order to unlock the improved sustainable transport solutions that comprise New Urban Mobility. These considerations also anticipate the role that technological change will play in the future of London's growth, transport provision and urban quality.

We have looked at a range of design interventions that could help contribute to this change now, but we have also acknowledged the impossibility of accurately predicting all the ways mobility will change in the future and how we can harness these changes for sustainable ends. As such, we have underlined the importance of ensuring developments are adaptive.

Finally, we have considered some of the systemic barriers to change. These encompass the procedural issues and structural limitations of the planning system, as well as the limiting range of incentives and interests in some models of development and management.

The recommendations that follow are aimed at tackling some of these barriers, focusing on how we can build, plan and finance developments with New Urban Mobility in mind.

Strengthen local political leadership

23 out of 32 boroughs have now declared a climate emergency. These declarations should be matched with practical action.

1. **Local authorities should prioritise New Urban Mobility in both strategic planning and development control.** This should include making sure parking provision is always compliant with London Plan standards, and where possible, even more ambitious in limiting numbers.

2. **Every London borough should designate a strategic development area as a "New Urban Mobility zone",** where they will work with developers to implement New Urban Mobility design principles (highlighted in Chapter 2) and regularly assess progress against a set of KPIs.

3. To encourage boroughs and developers to implement future mobility design principles, **the UK government, in partnership with the Mayor of London, should match-fund development receipts to support the development of mobility hubs** in new developments. This could be achieved by growing existing funding streams such as the government's Future Mobility Zones Fund and TfL's Liveable Neighbourhoods Programme.

Build adaptability into new developments

4. **Developers and landowners should take seriously the impact that developments built with sustainable transport in mind can have on "place value."**[47] There is substantial evidence demonstrating that dense, walkable neighbourhoods with low traffic levels and access to amenities, services, public transport and quality green space have a positive effect on both social value and property value.[48] As such, they represent a clear "win-win" opportunity. Some development models may more readily lend themselves to considering the long-term value of a place: for example, council-led developments, housing associations, build-to-rent models and community-led housing schemes all have incentives to consider the long term. However, more conventional development models should also recognise the interrelationship between mobility, place quality and long-term property values.

5. **Build out any barriers to adaptability.** Where car parking spaces must be provided, they should be built to specifications that will allow them to be converted to alternative uses more easily. For multi-storey or underground car parks, the materials used should allow future conversion to either residential, commercial or leisure use, and dimensions should be sufficient for appropriate ceiling heights. Similarly, car parking should be provided off-site where possible, to encourage the use of alternative transport and enable conversion in the longer term as technology, policy and preferences change.

6. **Local authorities should encourage more adaptable developments by:**

- **Fast-tracking sustainable adaptations.** In exchange for closer monitoring, permission could be granted more quickly for sustainable adaptations. In the same way that planning policies can encourage more and quicker delivery of affordable housing by fast-tracking applications which meet a particular threshold, adaptation could also be encouraged by offering "permission in principle" to changes which meet sustainable mobility-related aims.
- **Accommodating flexibility in discretionary standards.** Highways standards should not be a barrier to designing a future with a reduction in car use in mind. At a minimum, all local authorities must ensure that their technical standards are based on the most recent guidance, and should not exclude narrower carriageways, alternative materials, servicing underneath the highways or other design specifications that allow for modal shift and more sustainable transport choices. Generally, standards should anticipate change, rather than rely on historic surveys.

Unbundle parking spaces from homes

Future-proofing off-street residential parking would enable conversion to other uses as and when it is no longer needed as a residents' car park. But this becomes difficult if residents have bought individual parking spaces.

7. **To allow for re-programming of residential car parks into other uses, building and estate managers should offer renewable parking and charging membership to residents of new developments, rather than ownership of individual spaces.** This would also improve flexibility for residents – by making parking something they only pay for at the stages of life when they believe they need a car.

Improve post-completion evaluation

8. **London boroughs, in partnership with Transport for London, should evaluate new developments over time.** This should include an assessment of whether New Urban Mobility principles have been adopted – to inform future policy – as well as collection of data on how developments are being used, and the recommendation of adaptations where technology or residents' habits have changed.

Annexe

Illustrative sketches of a London development, showing how off-street parking can be future-proofed

Where car parking needs to be provided, how can it work with the principles of New Urban Mobility, and enable a transition to new uses, as private car ownership declines? Re-using plans from one of their recent London developments, Hawkins\Brown illustrate the interventions and design features that can make a basement car park convertible to other uses, in a future where New Urban Mobility becomes the most convenient way of moving around London.

2020;
Underground parking, which is built to meet planning requirements, is conceived with adaptability and sustainability in mind. Key interventions include:

- A wider structural grid, higher ceilings and reduced load above ground. These mean fewer columns are needed in the basement, to create larger areas of unobstructed and reusable space.

- Electric vehicle charging points are provided from the outset.

- Light wells where basement parking meets the street allow for partial lighting of future uses.

- A freight consolidation centre is located in the basement.

- A wider ramp allows delivery vehicles to access a consolidation centre, as well as segregated cycle lanes.

2030;

- The plant for processing car pollution in basement is replaced with bike storage as all cars become electric.

- There is a dedicated area for shared autonomous vehicles, which are more space efficient and now operational for local essential and emergency trips.

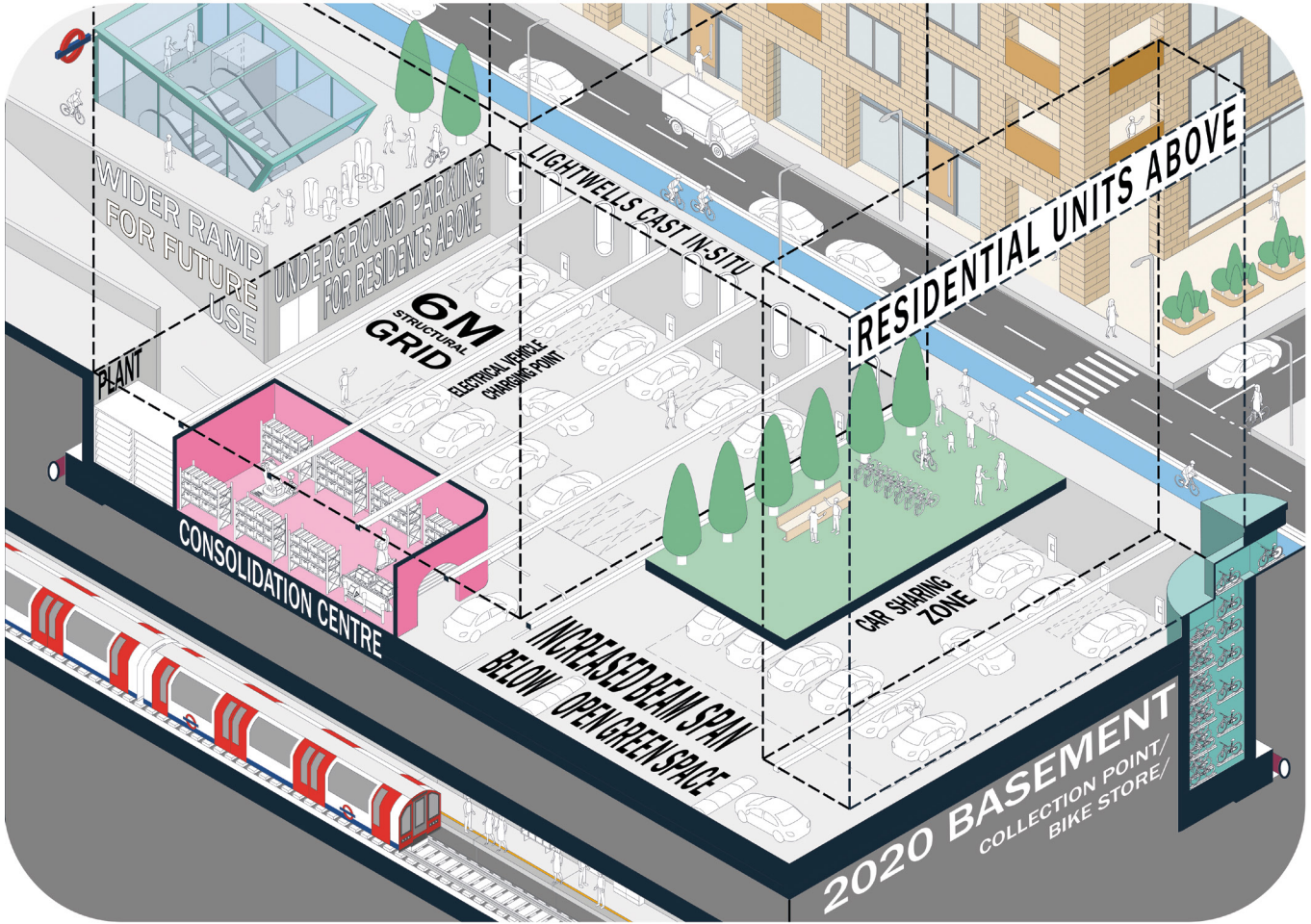
- The main road becomes a shared space dedicated primarily to pedestrians and cyclists.

2050;

- As private car ownership declines, car parking spaces are converted to retail and leisure uses.

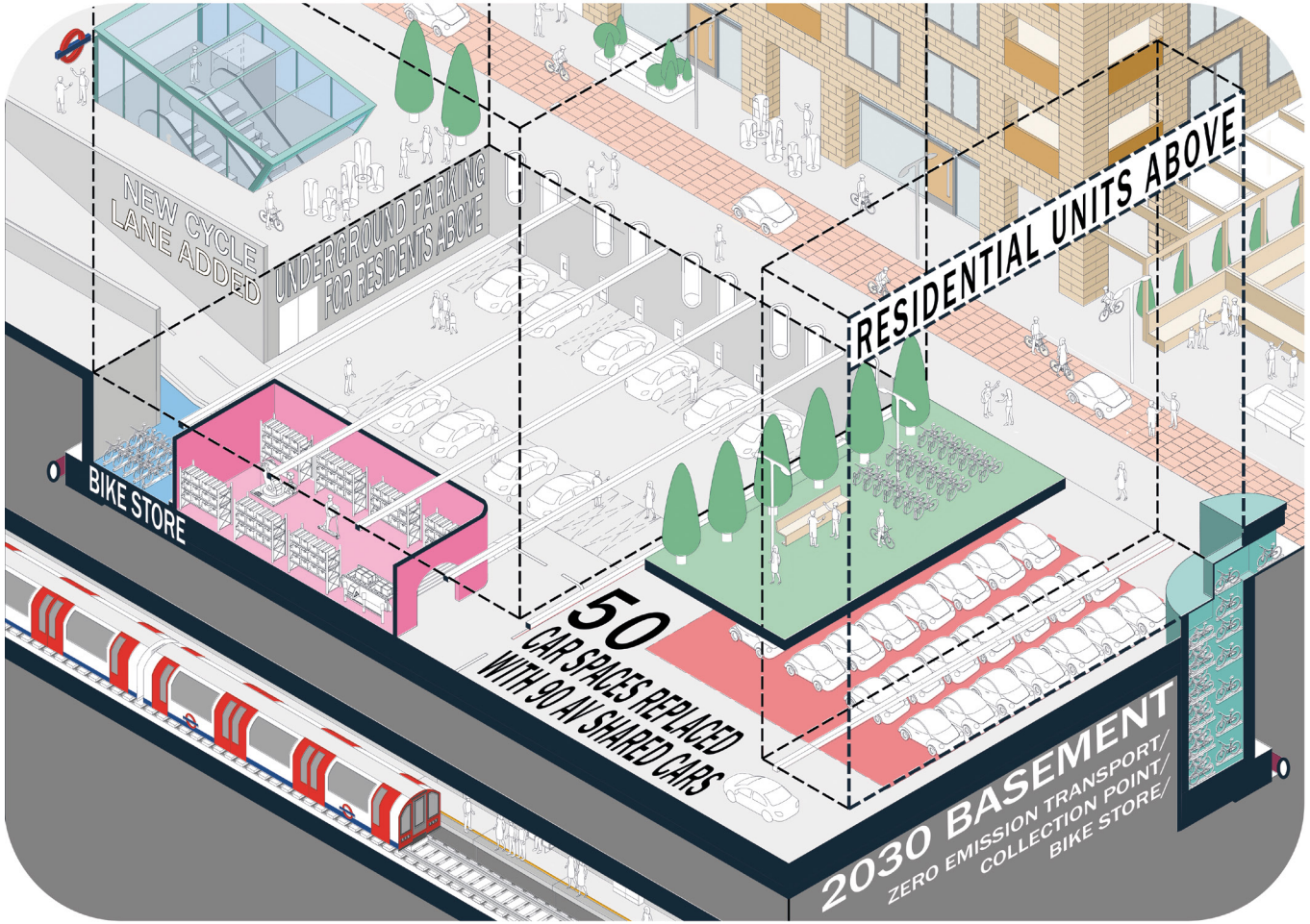
- As logistics chains become more efficient and sustainable, local deliveries are carried out through cargo bikes and electric vehicles.

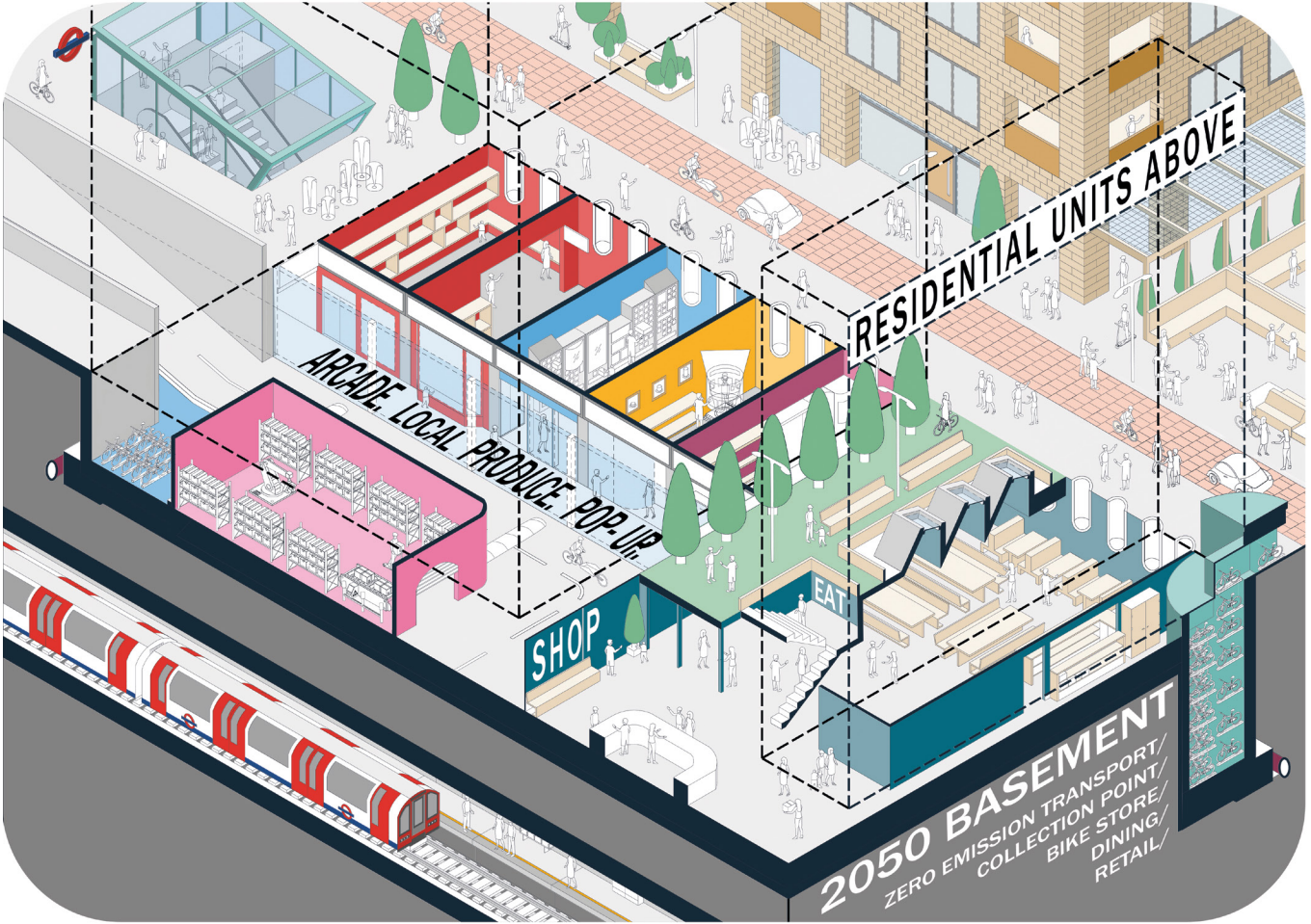
- Car sharing space becomes defunct if investment in public transport means it is no longer required – the space is replaced with restaurant and amenity area (accessed via the courtyard between residential blocks).



London basement in 2020

London basement in 2030





London basement in 2050

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