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The Challenge of Sustainably Increasing Housing Supply in Greater London & the Green Belt: A Spatial Analysis of New Build Development and Travel Sustainability 2011-22

The Challenge of Sustainably Increasing Housing Supply in Greater London and the Green Belt: A Spatial Analysis of New Build Development and Travel Sustainability 2011-2022

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Abstract

There is a consensus that housing supply in the London region needs to increase substantially to meet demand and try to mitigate record levels of unaffordability. There is not however agreement on the spatial distribution and form that this new housing should take. This paper analyses the geography of new build housing in Greater London and the wider region between 2011-2022 at neighbourhood (OA and MSOA) scale, focussing on the volume of housing delivery and travel sustainability outcomes. Development is analysed using the Energy Performance Certificate data, with additional data on prices per square metre, 2021 travel patterns, and affordable housing. The results show that successive London Plans have delivered high-density housing for boroughs with Opportunity Area sites, and that these developments are low carbon for both travel and energy efficiency metrics. London is however consistently short of its target for 52k dwellings annually, with wide discrepancies between boroughs, including in affordable housing. Changes to boost development in Outer London boroughs are needed. Meanwhile local authorities in the Green Belt have the lowest rates of housing delivery in the South East, high prices, and generally high levels of car dependence. A displacement or 'leap-frogging' effect is also evident, with housing development pushed beyond London's Green Belt, creating a ring of car-dependent housing. The results provide evidence in favour of Green Belt reform, which could increase housing delivery both in Outer London and the wider region. This analysis points to the expansion of existing towns and cities as the most sustainable means of increasing housing supply. Achieving this would require greater regional planning coordination and infrastructure investment.

1. Introduction

London and much of the wider South East region have developed increasingly acute housing affordability problems which have been widely described as a housing crisis (Edwards, 2016; Gallent, 2019; LHDG, 2021). While financialization processes and low interest rates in the last decade underlie much of the price rises, there has been a long-term shortage of housing supply (Edwards, 2016; Gallent, 2019). The rationale for building significantly more housing comes both from an equity perspective, with the aim of delivering more affordable housing for residents, and from an economic growth perspective, as prices are high in the most economically productive areas of the UK with high demand (Barker, 2006). Alongside these arguments for housing growth, environmental and sustainability perspectives are also crucial as we address the climate crisis and the requirements of reaching Net Zero (HM Government, 2021). New housing influences several sources of emissions including heating systems, travel patterns resulting from the location of housing, construction impacts and the land used for development. High quality new build integrated with public transport and services can deliver low household emissions (Wu and Skye, 2021), yet the UK's record on the quality and sustainability of new housing is very mixed (Carmona et al., 2020).

This paper analyses residential development patterns in London and the South East region for 2011-22 at the neighbourhood scale focussing on housing volume and sustainability, defined in terms of travel patterns and energy efficiency. Additional context is provided with house price data, housing type and affordable housing delivery. The main dataset used is the Domestic Energy Performance Certificate (EPC) data (DLUHC, 2023a) – a comprehensive record of all new build at property level. The EPC data is linked to property level price data and to travel behaviour data from the 2021 census. While new build housing from all tenures is considered, the price analysis here looks only at the owner-occupied sector.

There are two main research questions. The first is whether London Plan policies are maximising housing delivery across all London boroughs, including affordable housing. This question is answered through a spatial analysis of housing delivery over the last decade, mapping patterns of new build across Greater London, and looking at price, affordable housing and sustainability data. The second research question relates to the wider region and investigates housing development in the Green Belt, considering development volumes and prices in the last decade, and the sustainability of recent development in terms of travel patterns and energy efficiency. Housing delivery, price per square metre and mapping analyses are used to assess the degree of integration between London and Green Belt area housing markets. Data on travel sustainability in 2021 and EPC energy efficiency data is used to gauge the sustainability of new build housing from the last decade. The analysis includes all of the Greater South East, allowing Green Belt results to be compared to South East averages, and any housing displacement impacts to be identified.

2. Literature Review

Housing Affordability in London

House prices in London have increased substantially in the last two decades, pricing out households on moderate and low incomes from home ownership, and translating into rent increases, longer social housing waiting lists, increased overcrowding and homelessness (Edwards, 2016; LHDG, 2021). Price rises are strongly linked to the financialization of housing (Byrne, 2020; Gallent, 2019), which has occurred during a long period of low housing supply. Neoliberal market-led planning developed from the 1980s onwards has resulted in substantial falls in housing delivery, mainly through the erosion of public housing, which made up just under half of all supply between 1950-1980 (Edwards,

2016; Gallent, 2019). These housing shortages have become more acute during the last 13 years of Conservative-led government, with austerity hitting local authority housing budgets, and record low interest rates during the 2010s increasing borrowing and prices. Given this context of limited supply and high prices, the demand for affordable housing tenures in London has increased (Edwards, 2016), but delivery has been low (LHDG, 2021).

London Housing Policy
Land use and transport planning are a key responsibility of the Mayor of London, with the Spatial Development Strategy for Greater London – the London Plan – updated every five years, including targets for housing delivery (Mayor of London, 2016, 2021). Successive London Plans have been based on a high-density transit-oriented development model, with densification of Inner London, and clustered centres of growth at public transport interchanges linked to rail and metro upgrades (Rode, 2019). The target of the most recent plan is for 52k dwellings per annum (Mayor of London, 2021). This is lower than other estimates of housing demand (LHDG, 2021), including the 66k figure from the GLA's Strategic Housing Market Assessment (Greater London Authority, 2017). With austerity and volatile market conditions during the last decade, the GLA have struggled to reach housing targets. Limited land availability is a major constraint on housing delivery, with the London Plan relying on significant infrastructure investment to release development sites. London Plans have also included targets for affordable housing, with the 2004 target for 50% affordable housing (Mayor of London, 2004) reduced to a looser 40% target by Mayor Johnson in 2011 (Mayor of London, 2011), then reinstated as 50% 'genuinely affordable' by Mayor Khan as supplementary guidance in 2017, then as part of the 2021 London Plan (Mayor of London, 2021).

South East Planning and the Green Belt
With Greater London struggling to meet housing targets, the legacy of the Green Belt is a prominent research topic (Bowie, 2017; Mace et al., 2016). While the Green Belt has met its original aim of containing London, it has constrained growth and pushed up prices (Cheshire, 2014). Functional urban region analysis has shown that the Green Belt area is integrated with London in terms of economic links and commuting patterns (Hall and Pain, 2006; Reades and Smith, 2014). Housing supply could be greatly increased through the release of Green Belt land, with for example an estimated potential for up to 890,000 homes within 800m of existing Green Belt rail stations (Cheshire and Buyuklieva, 2019). Green Belt reform could also be a substantial source of revenue for austerity-hit local authorities (and/or fund development corporations), providing authorities can purchase Green Belt land at current use value and benefit from the land value uplift (Mace et al., 2016). There has been little recent change however in Green Belt planning policy, with the current National Planning Policy Framework strongly discouraging development (Mace, 2018).

The Green Belt has important environmental roles (Kirby and Scott, 2023), including biodiversity (also protected by SSSIs, Nature Reserves and AONB designations), flood prevention and water quality, and these roles need to be preserved and indeed enhanced. Yet the Green Belt also includes extensive agricultural land (with typically poor biodiversity), scrubland and near London a common use is golf courses (Cheshire and Buyuklieva, 2019). The current blanket ban is highly questionable. It is worth stressing how large the Green Belt land area is – 12.5% of all England (DLUHC, 2023c). London's Green Belt is 5,085km^2, more than three times bigger than Greater London. Even large-scale housing development at moderate densities would take up a small proportion of this total. For example, building 100k dwellings at a gross density of 40 dwellings per hectare would add up to 25km^2, or less than 0.5% of the London region's Green Belt area. Appropriate Green Belt reform could achieve both environmental improvements and sensible provisions for development, through

best practices such as Net Biodiversity Gain and using land value uplift to fund green infrastructure (Kirby and Scott, 2023).

Travel Sustainability and Housing

While the land preservation arguments against Green Belt development do appear to be solvable, there are further sustainability impacts from housing development to consider, including transportation and housing energy impacts. Transport is the largest source of GHG emissions in the UK – 26% of all emissions in the 2021 data (DBEIS, 2023). The path to Net Zero requires both the electrification of transport systems and a significant mode shift from private cars to public transport, walking and cycling (Department for Transport, 2021; HM Government, 2021). This sustainable mode shift can also bring wider health and quality of life benefits, from increasing exercise to improving air quality. Travel sustainability outcomes at the household level are linked to car ownership (Banister, 2005; Cervero, 1996), as well as socio-economic factors (Ewing and Cervero, 2001; Stead, 2001), and built environment and accessibility factors (Ewing and Cervero, 2010). Accessibility describes the ease of reaching jobs and services by different travel modes for typical trips, and thus the opportunities to use alternative modes (Geurs and van Wee, 2004; Handy and Niemeier, 1997). Housing development has an important role in travel sustainability outcomes through its influence on residential location, which is connected to car ownership, in terms of the density of housing and parking availability (Chen et al., 2008), and to accessibility, in terms of proximity to public transport and other services (Ewing and Cervero, 2010; Smith et al., 2020).

Greater London leads the UK in its comprehensive public transport network and sustainable travel outcomes (Transport for London, 2022), but this is not the case for the wider London region, much of which is car dependent. Large scale housing development in the Green Belt comes with the risk of expanding car dependence and increasing emissions. Researchers have argued that development close to rail stations would minimise this issue (Cheshire and Buyuklieva, 2019). Yet rail travel typically covers a minority of trips, and commuting is less prominent in the post-Covid19 era of flexible working. An addition to the rail station criteria would be for development to provide local access to a wider range of services, such as schools and retail. This approach relates to the concept of the 15 Minute City (Moreno et al., 2021), and to previous research into sustainable travel and settlement size. Larger towns and cities can reach economies of scale for public transport, meet more travel needs locally and typically have more sustainable travel outcomes (Banister, 2005; Smith, 2011). In the South East region, London is the only large city, and the Green Belt has constrained the growth of settlements around London. Reform could be used for the coordinated expansion of South East towns as a sustainable development model (Rudlin and Falk, 2014). This parallels the New Towns development in the post-war era (Hall, 2014), and arguably a similarly ambitious and coordinated approach is now required for the South East. Development corridors have also been proposed as a related but distinct sustainable development model (Mace, 2018).

Housing Energy Sustainability

Alongside travel sustainability, there are the energy impacts of new housing, including systems for space and water heating, and building energy efficiency such as the quality of glazing and insulation. Similar to travel sustainability outcomes, there are generally advantages from building housing at high densities (Steemers, 2003), as apartments reduce exposed wall areas and provide sufficient scale for low emission technologies such as district/community heating networks (Millar et al., 2019). Successive London Plans have strongly favoured the community heating network model (Mayor of London, 2016, 2021).

While higher density housing is generally more sustainable, there is a balance to be struck. Families often prefer housing with gardens (flats made up only 17% of dwellings in England and Wales

according to the 2021 Census) and recent post-pandemic trends have favoured larger properties to enable home working (Cheshire et al., 2021). While the high-density model has many advantages for London, there is also the need for medium-density suburban solutions, particularly in relation to the South East. It is possible to deliver low emission medium density housing – based on for example heat pumps, photovoltaics and high-quality insulation – with significant emission reductions compared to traditional suburban housing (Wu and Skye, 2021).

3. Data and Methodology

To answer the main research questions, we need comprehensive data on all new build housing in South East England at a detailed spatial scale. This data will then be linked to house prices, floorspace, and energy efficiency information. It is important to be able to calculate prices per square metre to account for the effects of house size differences between Inner London and the wider region. Travel sustainability will be analysed using the 2021 census data. The new build housing and price data is at individual property level, which is then aggregated to census zones, and to the local authority and subregional scales for summary statistics.

Housing Development Data

The most detailed and comprehensive dataset describing completed new build housing in England is the Domestic Energy Performance Certificate (EPC) data (DLUHC, 2023a). Housing from all tenures is legally required to produce an EPC before sale or renting. The EPC data includes an identifier to select new build properties, and is recognised as a reliable method of tracking new build (Greater London Authority, 2022). The EPC data is at property address level, and provides attributes on floorspace, housing type and estimates of energy efficiency and carbon emissions. The EPC data can be joined to Price Paid transaction data, as discussed below. There are two main limitations with the EPC data. The first is that it is a measure of total new build rather than net additional dwellings. Net additional dwellings data is available at local authority level (DLUHC, 2022), which can be used to check differences resulting from housing demolitions. A second limitation is that the EPC data does not provide a classification of new build properties by tenure. Additional local authority level data on affordable housing completions (DLUHC, 2023b) is therefore used to analyse affordable housing delivery.

House Price Data

Two main sources of house price data are used. Firstly, the Office for National Statistics House Price Index data provides modelled average prices of the entire housing stock at the local authority level (ONS, 2023). This is an accurate dataset and is used to provide an overview of prices over time. The second dataset, for detailed spatial analysis, is created by joining Price Paid transaction data to the EPC data (Chi, Dennett, et al., 2022; Chi, Livingston, et al., 2022). This data linkage allows price information in the owner-occupied sector to be measured per square metre, allowing normalisation between the varying house sizes. This approach measures the transacted stock only and is therefore at risk of sample selection bias when inferring prices for the whole stock. This sample bias is minimised by averaging transactions annually and taking median values, which produces a close match between with the House Price Index data (R^2 of 0.985 using 2021 local authority data).

Travel Sustainability Index

Census 2021 data for the Greater South East has been used to create a travel sustainability index, using car ownership, journey to work mode choice, and residential population density variables. The correlations between the variables are shown in Table 1, highlighting very strong relationships in describing different aspects of car dependence and travel sustainability. Note that working from

home results are excluded from the journey to work variables, due to the exceptionally high levels of home working in March 2021 of 31% nationally. The travel behaviour index should avoid being a proxy for income. This is tested in Table 1, confirming that the correlation coefficients with income are low, though note there is a moderate positive correlation with public transport commuting, reflecting higher than average incomes for workers living in, and commuting to, London. To create the combined index, the car ownership, journey to work and density variables were rescaled, standardised so that higher values describe lower car use, and then combined into a travel sustainability index from 0-100 at the Output Area scale. The index uses three commuting variables, which is a limitation (data for other trip types is not available for small zones). To try and minimise this issue, the car ownership variable has been double weighted in the travel sustainability index.

Table 1: Travel Sustainability Variables Census 2021 Pearson Correlation Coefficients, MSOA Scale

	Car Ownership (1 or more cars %)	Car JTW %	Public Transport JTW %	Walk & Cycle JTW %	Residential Net Density	Total annual income 2018[1]
Car Ownership (1 or more cars %)	1	.930**	-.819**	-.639**	-.825**	.082**
Car JTW %	.930**	1	-.915**	-.627**	-.808**	-.183**
Public Transport JTW %	-.819**	-.915**	1	.261**	.755**	.196**
Walk & Cycle JTW %	-.639**	-.627**	.261**	1	.474**	.054*
Residential Net Density	-.825**	-.808**	.755**	.474**	1	0.012

** Correlation is significant at the 0.01 level (2-tailed).   * Correlation is significant at the 0.05 level (2-tailed).   [1] ONS Small Area Income Estimates

The index summarises the travel behaviour of all residents in the Greater South East in 2021. This metric is then used to estimate travel behaviour of residents in new build housing built between 2011-2022, based on the location of all new build housing. This approach assumes that residents of new build housing have consistent travel behaviour with their neighbours in the same zone, though there may be some differences linked to the demographics of new build residents. To minimise this issue, the most detailed census geography of Output Areas (Cockings et al., 2011) – the average population of each OA in the Greater South East is 324 residents in 2021 – is used for the travel sustainability index and spatial match to new build. Local travel differences are in the context of much greater regional variation, which ranges from the least car dependent areas in the UK in Inner London, to some of the most car dependent areas in the UK in the wider South East.

Energy Efficiency Analysis

The Energy Performance Certificate data provides a series of variables on the energy efficiency of homes and estimated carbon emissions, based on the structure and materials of the dwelling, and the space and water heating systems used (DLUHC, 2023a). Key factors in building sustainability are recorded and used in the emission estimates. Although there are limitations with this approach, both in the EPC methodology (Hardy and Glew, 2019) and the lack of information on household behaviour, it is useful to have the EPC energy efficiency metrics as a basis to estimate energy sustainability patterns for new build housing, and compare these to the travel sustainability results.

4. Study Area and Sub-Regions

To address the main research questions, we define the subregions shown in Figure 1: Inner London, Outer London, the Green Belt and the Rest of the South East. The entire study area is the Greater South East. The Inner and Outer London subregions use the Greater London Authority (GLA)

definitions from the London Plan (Mayor of London, 2021). Note that the East London boroughs of Newham and Greenwich, both of which have major development sites, are included in Inner London.

Defining a Green Belt subregion is necessary to answer questions on Green Belt impacts. The boundary is based on defining MSOA zones beyond Greater London which are majority Green Belt land, producing a close match to the Green Belt as shown in Figure 1. Towns that are surrounded by Green Belt land, such as Luton and Southend, are included. Note also that there is also considerable Green Belt land within Greater London – 348km^2 or 22.1% of the GLA (DLUHC, 2023c) – which influences development in the Outer London. Oxford and Cambridge, which have their own local Green Belts, are not defined as part of the Green Belt subregion. Finally, we define the area beyond the Green Belt subregion and within the Greater South East as the Rest of the South East. This extensive area is included as a means of comparison for the Green Belt and London results.
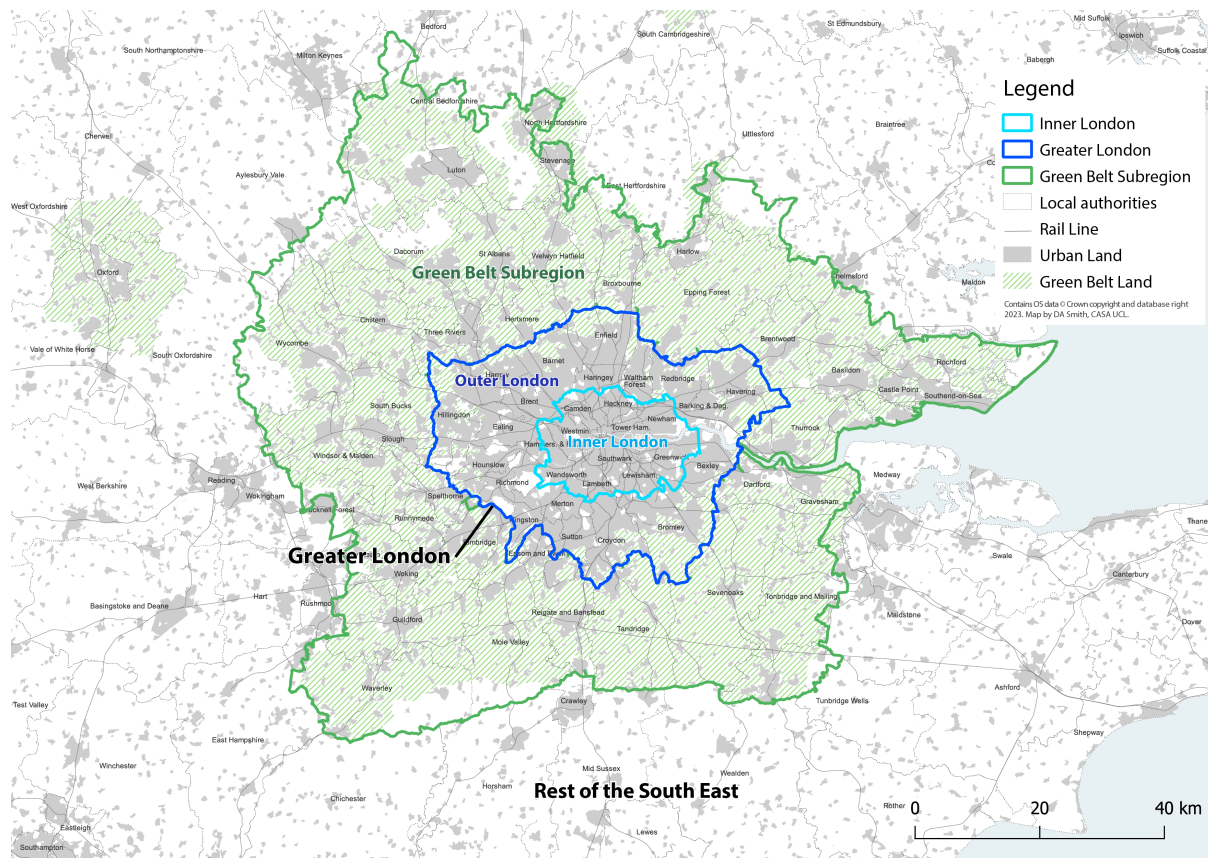
Figure 1: London and the South East: Study Area and Subregion Definitions.

Table 2: Population of Study Area and Subregions

	Population 2011	Population 2021	Population Change	Land Area (km^2)
Inner London	3.23m	3.42m	190k (+5.9%)	348
Outer London	4.94m	5.38m	436k (+8.8%)	1,247
Greater London (GLA)	8.17m	8.80m	626k (+7.7%)	1,595
Green Belt	4.62m	4.89m	273k (+5.9%)	6,346
Rest of South East	9.87m	10.73m	867k (+8.8%)	32,651
Greater South East	22.66m	24.42m	1,766k (+7.8%)	40,592

Both the Green Belt and Rest of the South East subregions are large and varied, with both urban and rural areas, including considerable variety in housing types and prices. These differences will be analysed using mapping analysis at MSOA scale and by additional analysis at local authority scale (local authority names are shown in Figure 1). The overall population, population change and land area of the subregions is shown in Table 2. London and the South East region have continued to grow in the last decade, with Greater London reaching a record 8.8 million residents in 2021 (this figure is also likely an underestimate due to the Covid-19 lockdown in March 2021). The highest growth rates are in Outer London and the Rest of the South East. The Green Belt subregion area is extensive at over 6,300 km^2, which is four times larger than Greater London.

5. Results and Analysis

The results section is organised as follows. Firstly, we look at house price data in Section 5.1 to gauge how high prices have reached in the last decade and the effects on affordability. Data is analysed at the subregional and MSOA level to understand spatial variation. Next in Section 5.2 we analyse the housing development data, first by subregion, then by local authority and MSOA mapping. The key questions for Greater London are whether housing targets from the London Plan are being met, and how the geography of development varies between London boroughs. We also analyse affordable housing development, assessing variation in affordable housing delivery between London boroughs. For Green Belt local authorities, the main question is how development volumes compare to similar local authorities in the wider South East, and whether there is any displacement of development beyond the Green Belt boundary. Following the price and development analysis, we then look at the impacts of development in terms of travel sustainability in 5.3 and energy efficiency in 5.4. The aim is to identify areas that are more or less sustainable compared to the subregional averages.

5.1   Housing Market Analysis

5.1.1   House Price Change and Affordability Overview

The average price of housing for the last 15 years is graphed at subregional level in Figure 2. Prices in London doubled between 2009 (the low point following the global financial crisis) and the end of 2016, with Inner London average prices reaching a record £580k and Outer London £420k. During this period, UK interest rates were reduced to 0.25%, lowering mortgage rates and boosting prices. The overall impact has been to significantly reduce levels of housing affordability. The median house price to income ratio for Inner London soared from 9.9 in 2008 to 15.1 in 2016; for Outer London the ratio increased from 8.2 in 2008 to 11.8 in 2016. Overall Greater London figures are 8.7 in 2008 and 12.9 in 2016. In addition to high prices, first-time buyers have also been hit with record mortgage deposit requirements, with average deposits reaching £148,000 for Greater London, compared to around £10,000 in the late 1990s (Greater London Authority, 2022). Owner occupation is now effectively impossible in Inner, and much of Outer, London for low- and moderate-income first-time buyers.

We are interested in the degree of integration between prices in the Green Belt subregion and Greater London. It is clear in Figures 2 and 3 that the Outer London and Green Belt subregions track each other closely in terms of prices, indicating that they are part of an integrated housing market. Figure 3 shows median prices per square metre (calculated by joining the EPC and Price Paid data) to account for differences in dwelling sizes. Figure 3 has very similar trends to Figure 2, though there is

moderately more separation between the Green Belt and Outer London subregions due to larger property sizes in the Green Belt. Green Belt prices are closer to Outer London than they are to the Rest of the South East average, with a premium on Green Belt housing of around £90k or £1k per square metre compared to the Rest of the South East.
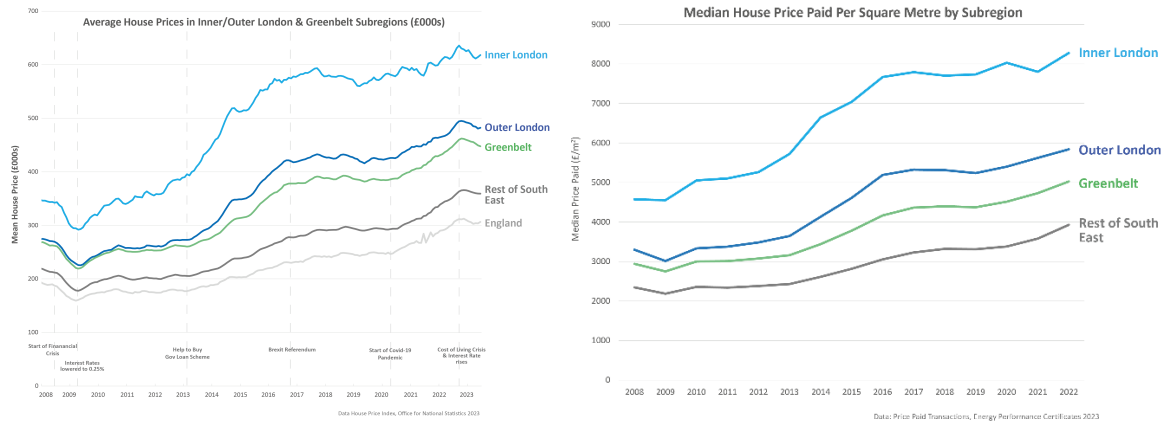
Figures 2 & 3: Average House Prices 2008-2023 by Subregion (left); Median Price Paid Per Square Metre by Subregion (right)

The price graphs also show significant changes after the start of the Covid-19 pandemic. Following a period of stable prices between 2017-2020, they rise again in 2020. Covid-19 lockdowns and flexible working practices appear to have increased demand for larger homes, subsequently increasing prices in Outer London, the Green Belt and Rest of the South East subregions, but less so in Inner London. These rises came to an end in 2023, as interest rates have increased rapidly to try and reduce high inflation following energy price shocks.

The subregions are also characterised by differences in housing type, as shown in Figure 4. Inner London is dominated by flats at 71.4% of households, and this is also the most common type in Outer London at 42.7%. The Green Belt and Rest of South East subregions are fairly close to each other in their proportions of dwelling types, though with more low-density detached housing in the Rest of the South East. The average prices per square metre for these housing types is shown for London in Figure 5. Although flats having the lowest overall dwelling price, they are highest price per square metre due to their prevalence in Inner London. This graph confirms the changes after the Covid-19 pandemic seen in Figures 2 and 3, with a notable increase in the price per square metre of detached, semi-detached and particularly terraced housing from 2020 onwards.

Figures 4 & 5: Dwelling Type Proportions by Subregion 2021 (Data: Census 2021) (left); London Median Price Paid Per Square Metre by Housing Type 2008-2022 (right)

5.1.2   House Price Mapping Analysis

There is considerable variation below the subregional scale, and we now switch to the MSOA level mapping analysis. This is based on the Price Paid transaction data per square metre, using median prices in 2021. The results are mapped in Figure 6, clearly showing very high prices in Inner London, and four radial corridors of high prices extending beyond Greater London into the Green Belt. The two corridors of affluence extending north-west and south-west from Central London are a long-established historical pattern. A more recent change is that East London is mirroring West London with two radial corridors of higher prices extending north-east and south-east from Inner East London, creating an overall 'X' shape of high prices across the London region.

The two eastern radial corridors are the primary areas of gentrification in London in the last decade (Smith, 2022), squeezing out what was previously London's largest area of affordable market housing. Note the East London radial corridors appear more strongly in per square metre data due to differences in average dwelling sizes between East and West London. In addition to the radial corridors, there is also a very distinct spatial alignment between London's Green Belt boundary and higher prices, with a premium of around £1k per square metre within the Green Belt. This is further evidence of strong regional housing market integration, and that Green Belt restrictions are very likely pushing up prices. Unlike Greater London, the Green Belt still retains some more affordable areas (e.g. the Thames Estuary, Luton and Harlow), although some previously affordable towns are showing signs of gentrifying (e.g. Watford). Overall, there is a strong pattern of radial corridors of high prices extending from Inner London into the wider region, and a price premium within the Green Belt boundary.
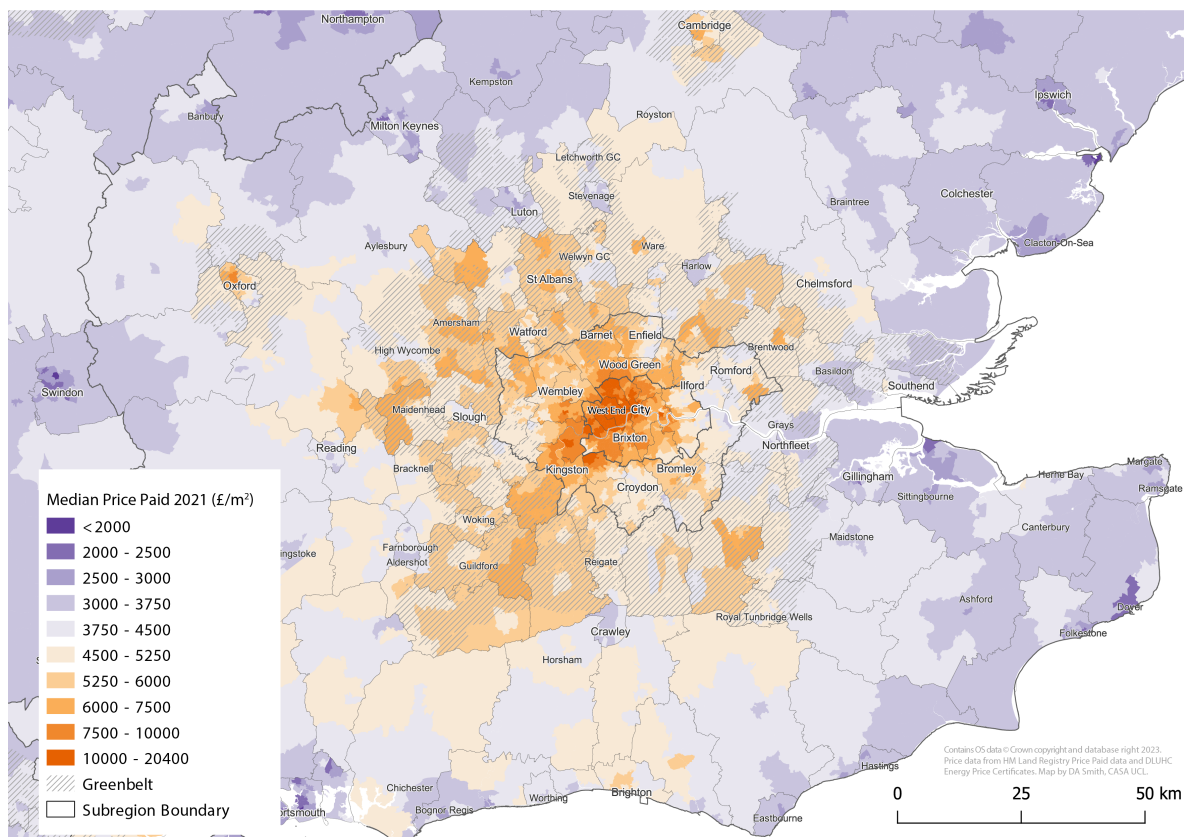

Figure 6: Median Price Paid Per Square Metre 2021 at MSOA Scale for the South East

5.2 Housing Development Data

We begin with a subregional overview of development volumes in Section 5.2.1, then move to more detailed spatial analysis in Section 5.2.2 at MSOA and local authority level. Finally, we address affordable housing delivery in Section 5.2.3.

5.2.1 Subregional New Build Analysis

The annual new build dwellings by subregion from 2009-2022 is shown in Figure 7. Beginning with Greater London, the annual new build total fell to a low point of 18k new dwellings in 2010, then steadily increased to 40k between 2016-2019, before falling to around 35k during the Covid-19 pandemic. These annual totals are well short of the current London Plan target for 52k, and London has consistently missed its overall housing targets in the last decade. Furthermore, the recent impacts of the pandemic and high interest rates have lowered market housing starts (Greater London Authority, 2022), meaning that London will continue to miss its targets in the near future. Note that Figure 8 also includes the ONS net additional dwellings data for London as a validation for the EPC calculation method, confirming that the datasets are closely aligned, with the minor discrepancy resulting from demolitions, estimated at 24k in London between 2011-2021.

The Rest of the South East subregion shows annual development rates quite similar to London up until 2017, then it moves ahead to around 50k dwellings from 2019 onwards. There is comparatively low new build activity in the Green Belt subregion, which begins at 10k dwellings per annum in 2009 and increases to 20k in 2018. This is evidence of Green Belt regulations working very effectively to restrict development. We can confirm this conclusion using the official Green Belt statistics, which calculate that the London region Green Belt land area was 5,160km^2 in 2011 and 5,085km^2 in 2022 (DLUHC, 2023c). Therefore, only 74km^2 or 1.4% of Green Belt land was released over the decade, and this land was not necessarily for housing development. Given the housing affordability crisis, Green Belt restrictions have been applied very inflexibly during this period.
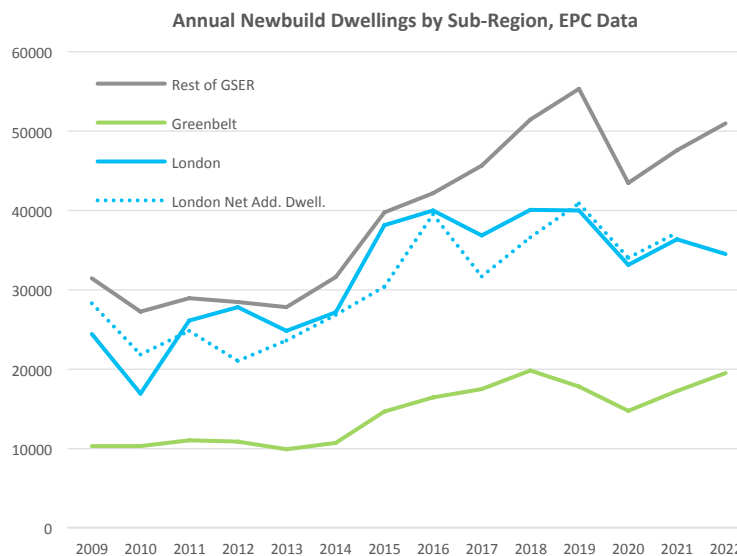

Figure 7: Annual Newbuild Dwellings by Subregion 2009-2022 (Data: Energy Performance Certificates)

The types of new build housing developed by subregion are shown in Figure 8 as a total of the years 2011-2022. London development is completely dominated by flats at 88% of all new build. This approach clearly maximises dwellings per unit of land area, and is also linked to sustainability advantages (see Sections 5.3 and 5.4). On the other hand, the dominance of flats has coincided with

increases in prices for medium and low-density housing types as shown previously. The proportion of flats is also high for the Green Belt subregion at 51%, though this is in the context of low overall delivery levels. The Rest of the South East has a more balanced distribution of housing types, including 31% flats, and a much higher proportion of detached houses at 29%, reflecting more car-dependent development.
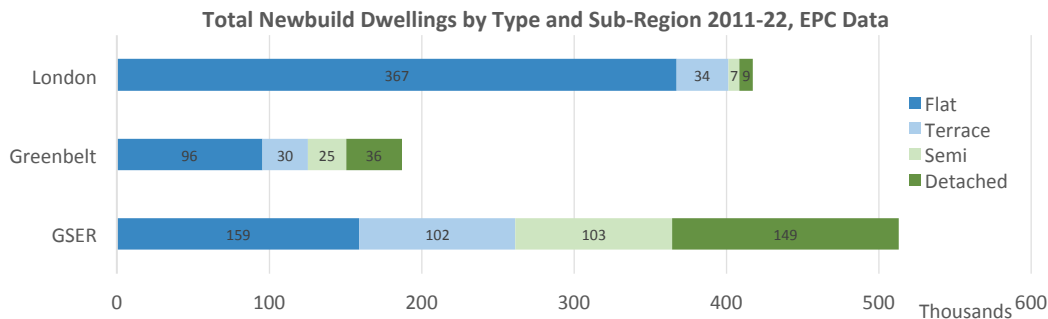
Total Newbuild Dwellings by Type and Sub-Region 2011-22, EPC Data

Figure 8: Newbuild Totals by Type and Subregion, thousands, 2011-2022 (Data: Energy Performance Certificates)

5.2.2   New Build Spatial Analysis

We now switch to the more detailed mapping analysis of new build housing, looking firstly at Greater London then the South East region. Successive London Plans have integrated high density housing with public transport stations at major development sites, which are termed Opportunity Areas. We can see the results in Figure 9 where new build totals are mapped at MSOA level. It is clear how development is clustered at high densities in major Inner and East London Opportunity Areas such as the Canary Wharf, North Greenwich and the Olympic Park at Stratford. New build activity is much more limited in Outer London, restricted to a few major sites such as Croydon and Wembley. New public transport infrastructure has been closely integrated with housing development, as shown in Figure 9 where the Elizabeth Line has enabled development in areas such as Ealing, Park Royal and Woolwich.

Moving to the wider region, we repeat the mapping analysis for the Green Belt and South East in Figure 10. This reveals a strong contrast between generally low development activity within the Green Belt subregion (apart from several town centres such as Luton, Hemel Hempstead and Dartford) and a ring of high development activity just beyond the Green Belt boundary. This development ring includes dispersed car-dependent development (consisting of detached and semi-detached housing), as well as the expansion of medium-sized towns and cities such as Milton Keynes, Bedford, Reading, Bracknell, Crawley and Maidstone. This pattern looks very much like Green Belt restrictions are pushing development beyond the Green Belt boundary. An important caveat here is that several South East towns and cities have dynamic economies in their own right and their own development demands. This is particularly the case north-west of London where the Oxford-Milton Keynes-Bedford-Cambridge axis includes agglomerations of technology industries (Cambridge Econometrics, 2016). There have long been calls for a new railway line to integrate growth in this corridor (Hall and Tewdwr-Jones, 2019), the first stages of which are now under construction (Network Rail, 2023).
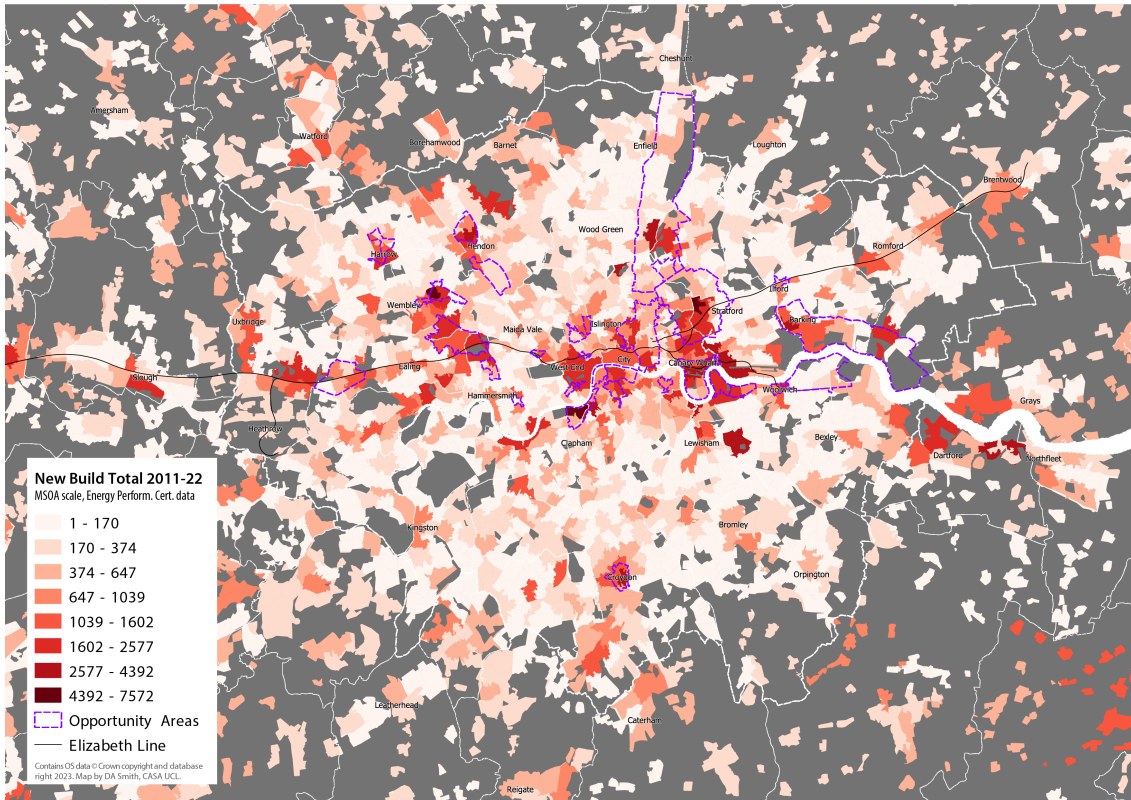
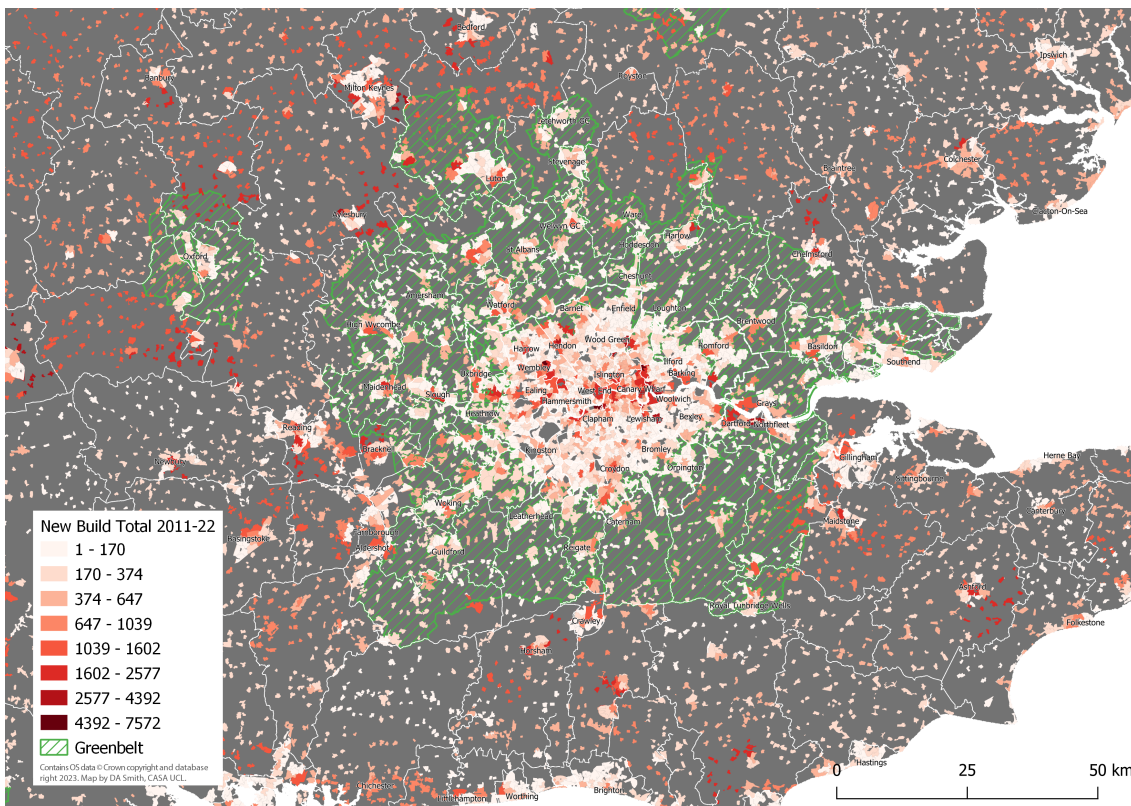Figure 9: Greater London Newbuild Dwellings by MSOA 2011-2022 (Data: Energy Performance Certificates)

Figure 10: South East Newbuild Dwellings by MSOA 2011-2022 (Data: Energy Performance Certificates)

It is also useful to summarise the new build data at local authority level, as plotted in Figure 11. This clearly highlights low development in nearly all Green Belt local authorities, high development in most of Inner London, and variable outcomes for Outer London and the Rest of the South East. The Inner East borough of Tower Hamlets delivered a massive housing total of 38k dwelling units (note the net additional dwelling figure is 32k due to high rates of demolition in this borough). Nearly all the boroughs with high delivery in both Inner and Outer London contain Opportunity Areas: Canary Wharf in Tower Hamlets; the Olympic Park in Newham; Battersea Power Station in Wandsworth; Hendon-Colindale in Barnet; Wembley in Brent; Old Oak Common-Park Royal in Ealing; and Croydon town centre. Given that there are only a few Opportunity Areas in Outer London, this leads to relatively low delivery in most Outer London boroughs, and points to the need for a wider strategy for Outer London development. Beyond the GLA, Green Belt authorities have low housing delivery. The exception is Dartford, which is a special case as it includes the Ebbsfleet development site linked to the High Speed 1 rail line. The Rest of the South East local authorities are much more varied, with high development in Milton Keynes and Bedfordshire, as well as significantly higher average delivery compared to the Green Belt authorities.
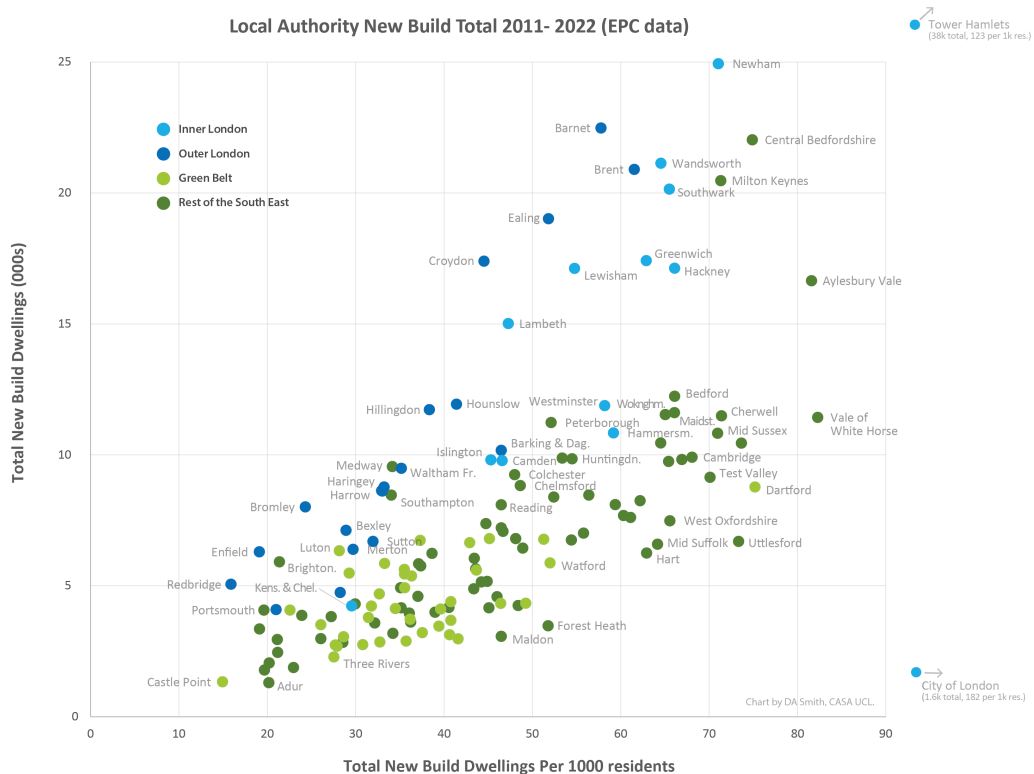

Figure 11: Newbuild Dwellings by Local Authority 2011-2022 (Data: Energy Performance Certificates, Census 2021)

5.2.3   Affordable Housing Analysis

Given the extremely high house prices in London and the South East, there is more need than ever to deliver alternatives to market housing. Funding for affordable housing delivery has been limited in the last decade, and targets for affordable housing were weakened by the previous Mayor of London. Annual additional affordable housing completions are shown for London in Figure 12 and for the Green Belt and Rest of the South East subregions in Figure 13. Affordable housing delivery increased during the early 2000s up to 2010 before entering a volatile period of decline from 2011-

2015 post the financial crisis. There has been a steady increase in affordable housing from 2016 to 2022 in both London and the Rest of the South East subregions. Note also the dilution of affordable housing with genuinely affordable social rent housing falling from 60% of completions in 2010, to a third in London in 2022 and considerably less in the South East subregions.

Overall, out of the 347k net additional dwellings delivered in Greater London from 2011-2021, 35.9% were affordable housing, and only 10.8% social rent and London Affordable Rent. This is considerably short of the 50% affordable housing delivery target. The figures for other subregions are worse, with 25.9% affordable housing in the Rest of the South East of which only 4.8% was social rent, and 23.4% affordable delivery in the Green Belt with 5.3% social rent. The current Mayor of London has responded to the affordable housing shortfall by negotiating central government funding for more affordable homes, resulting in increased affordable housing starts of 18,800 in 2021-2022 and 25,700 in 2022-23 (Mayor of London, 2023). These figures include more than 50% social rent and London affordable rent tenures.
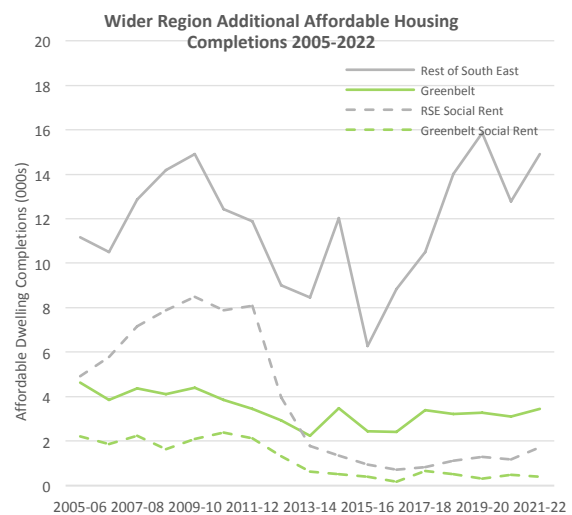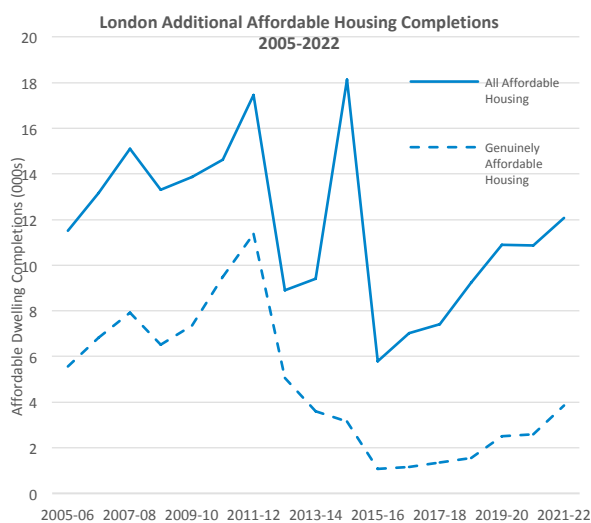
Figures 12 & 13: Additional Affordable Dwelling Completions 2005-2022 in London (left) and the Wider South East Subregions (right)

There are further variations in affordable housing delivery at the local authority level shown in Figure 14, which graphs additional affordable housing completions against net additional dwellings 2011-2021. All the local authorities delivering higher volumes of affordable housing are doing so in the context of substantial market development, reflecting the UK's cross-subsidy model. Yet within this context, the variation in proportions of affordable housing is considerable, from as low as 5% to over 50%.

Generally Inner London boroughs do well in affordable housing delivery, including three of the highest delivery boroughs: Tower Hamlets, Newham and Southwark. The two Inner London outliers are the City of London at 5.4% and Hammersmith and Fulham at 12.6%. Several Outer London boroughs also score well in affordable housing delivery. Barking and Dagenham and Waltham Forest both exceed 50% affordable housing delivery, while Brent, Ealing and Hounslow all exceed 30%. There appears to be a political effect, with more left-wing Labour-led boroughs delivering more affordable housing (e.g. Waltham Forest, Barking and Dagenham, Hackney) while some boroughs that were Conservative-led in the 2010s, such as Wandsworth and Barnet, are below 25% (which is below the average for the Rest of the South East) despite high overall development. It is likely that the removal of the London Plan 50% affordable target in the 2011 London Plan weakened pressure

of borough councils to extract higher proportions of affordable housing, contributing to a wide range of affordable housing outcomes.
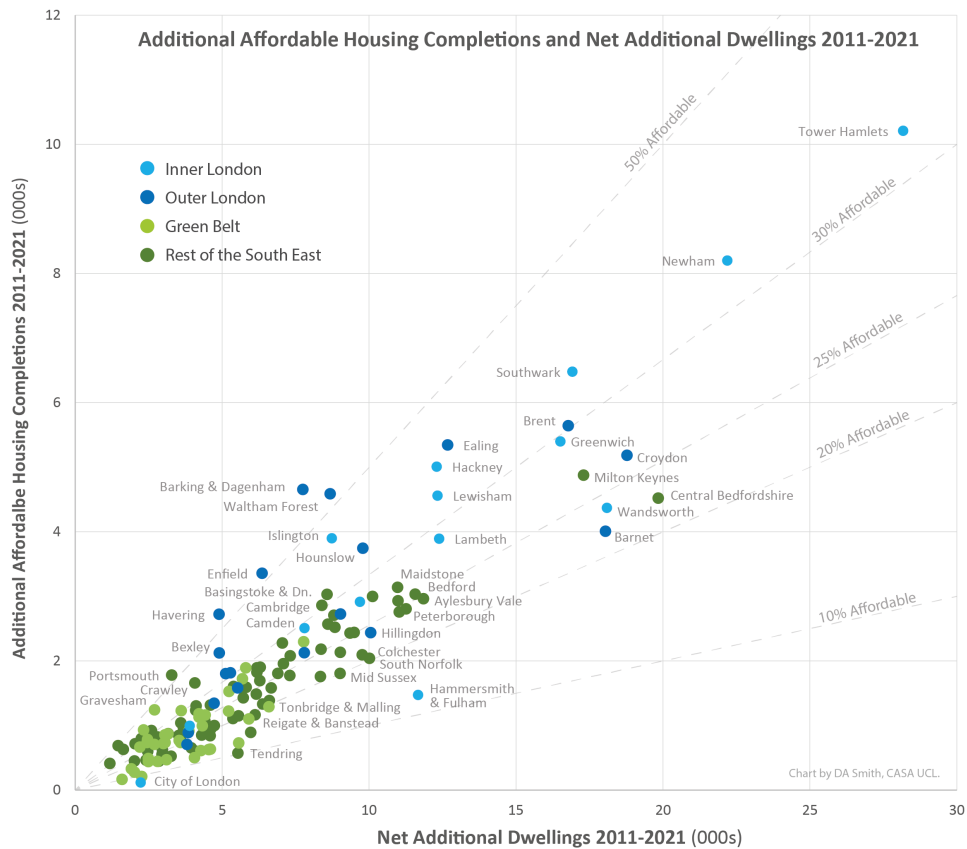

Figure 14: Additional Affordable Housing Completions and Net Additional Dwellings by Local Authority 2011-2021

Affordable housing delivery in Green Belt local authorities is generally low, with the only authority reaching 2k affordable completions being Dartford, which is a special case due to Ebbsfleet. Luton and Dacorum also score above average, with just short of 2k completions. The Rest of the South East authorities are also generally quite low, but with several exceptions. Milton Keynes and Central Bedfordshire both clear 4k affordable completions, with Milton Keynes in particular reaching 28.2% affordable housing. Bedford and Maidstone also exceed 25% affordable housing, while Cambridge and Basingstoke and Dean reach 35% affordable housing of 8.5k total completions. Generally, most authorities in the Rest of the South East are below 2k affordable housing completions across the decade.

5.3 Travel Sustainability Analysis

In this section we classify Output Areas according to travel behaviour in 2021, and use this classification to estimate the travel behaviour of residents in new housing built between 2011-2022. The travel sustainability classification is based on car ownership and commuting mode choice from the 2021 census data with an additional residential density variable. These variables are normalised and combined to create a travel sustainability index, which is then then classified into six travel sustainability groups with around 4 million residents each, as shown in Table 3. The London region covers a very wide range of travel behaviours, from as low as 20% commuting by car and 62% zero car households in the most sustainable class 1; to as high as 87% car commuting and 6% zero car

households in the most car-dependent class 6. Table 3 also shows the average house price per square metre in each class, which illustrates how expensive the most accessible classes are and the resulting price incentives for households to move to more car-dependent areas.

Table 3: Travel Sustainability Index Classes Average Statistics, Output Area (2021 census data)

Travel Sustainability Class	Travel Sustain. Index	Car Commuting %[1]	Public Transport Commuting %[1]	Walk & Cycle Commuting %[1]	Car Owning Households %	Residential Net Density (pp/km^2)	Total Population in South East	Aver. House Price 2021 (£/m^2)
1	45-82	20.3	48.5	26.4	38.3	51.5k	3.56m	8.3k
2	30-45	41.6	33.2	20.9	61.5	32.1k	4.03m	6.2k
3	21-30	60.6	18.1	17.6	74.7	25.0k	4.03m	4.8k
4	15-21	71.6	10.9	14.2	83.3	20.2k	4.16m	4.1k
5	10-15	80.0	6.5	10.9	89.4	16.4k	4.34m	4.2k
6	1-10	87.3	3.6	6.7	94.1	11.1k	4.29m	4.0k

[1]Home workers excluded from commuting statistics. The 2021 census was recorded in March 2021 during a national lockdown with very high levels of home working.

The results of the classification are mapped in Figure 15, highlighting the stark travel behaviour differences between Greater London and the wider region. The Inner London population-weighted average travel sustainability score is 51.6 (class 1), and Outer London is 32.1 (class 2) – though note the steep drop to more car dependent classes at the Outer London fringe. The Green Belt subregion is overwhelmingly comprised of more car dependent classes 4 and 5, with an overall population-weighted average of 16.4 (class 4). Although the Rest of the South East has extensive rural land in class 6, its population-weighted average score is nearly identical to the Green Belt at 16.5, emphasising the disappointing levels of car dependence in the Green Belt despite its rail infrastructure and proximity to London.
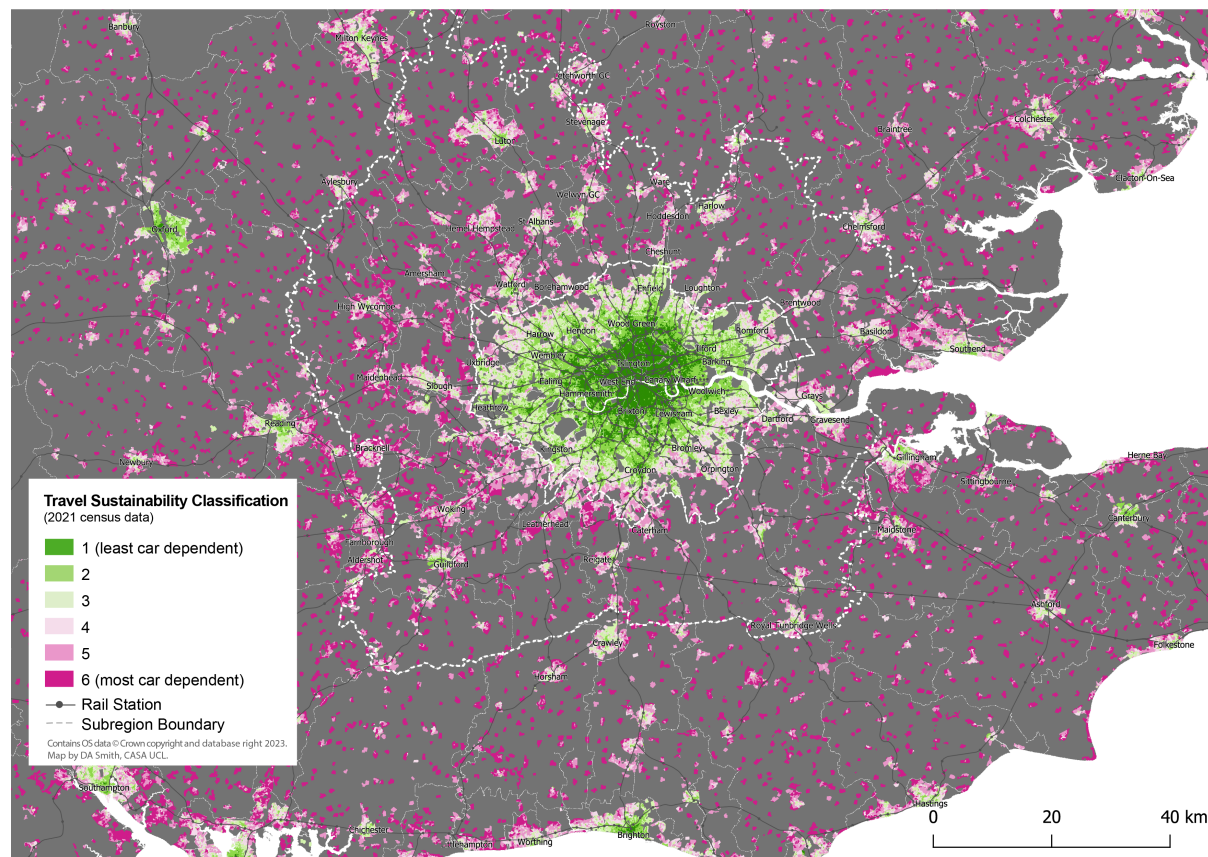

Figure 15: Travel Sustainability Classes in the London Region 2021

There are some interesting regional trends in Figure 15 that could form the basis for future sustainable development approaches. Larger towns and cities have more sustainable travel outcomes, including the Green Belt towns Luton, Watford, Guildford and Southend, and wider South East towns and cities including Reading, Oxford, Gillingham, Brighton and Southampton (Cambridge and Norwich, cropped in Figure 15, also score well). Generally, this confirms the correlation between larger settlements and more sustainable travel patterns (Banister, 2005). Additionally, higher density, active travel-oriented cities do better (e.g. Brighton and Oxford), while some lower density 20th century new towns do worse (e.g. Milton Keynes and Hemel Hempstead). While all settlements with better travel sustainability outcomes have at least one rail station, there are also many small Green Belt settlements with rail stations that fall into car dependent classes 5 and 6, particularly west and south west of Greater London in Surrey and Berkshire. This analysis shows that proximity to rail infrastructure is a necessary but not sufficient condition for achieving sustainable travel outcomes, and that additional factors (settlement size, accessibility to services, density) should be prioritised when identifying Green Belt land for sustainable development.

We can use the travel sustainability classes to summarise the subregional population and new build dwellings by travel behaviour. Figure 16 shows the total population in each subregion in 2021 according to the travel sustainability classes, and Figure 17 shows the new build dwellings between 2011-2022 assigned to the travel sustainability class of their Output Area locations. London is dominated by the most sustainable classes in 2021. Furthermore, London's new build patterns are greatly boosting populations in the most sustainable travel classes over time, especially class 1 which accounts for a massive 65% of new build dwellings.

Figures 16 and 17: Subregional Population 2021 by Travel Sustainability Class (top); New Build Dwellings 2011-2022 by Travel Sustainability Class (bottom)

The pattern for the Green Belt is more car dependent, with only a few town centres that reach the top two classes, and with the majority of the population in more car dependent classes 4, 5 and 6. The Green Belt new build pattern is proportionally similar to the existing population. The Rest of the South East region includes a relatively small population in town and city centres that are classed in the top two groups, while most of the population are in the car dependent classes, including 30.5% of the population in the most car dependent class 6. Furthermore, the Rest of the South East new build pattern is creating a less sustainable residential population over time with 330k new dwellings built in the most car dependent classes 5 and 6 (39% in class 6).

Finally, we chart the new build travel sustainability results against total new build delivery at local authority level in Figure 18. The higher the Travel Sustainability Score, the more sustainable the travel patterns (this is a weighted average based on the number of dwellings). Inner London boroughs score highly with this measure, appearing at the top of the chart, followed by Outer London boroughs. It is interesting several Outer London boroughs overlap with the most sustainable urban authorities in the wider region, including Brighton, Cambridge, Reading, Norwich, Oxford, Portsmouth, Luton, Southend, Watford and Slough. This indicates that new build dwellings are generally more sustainable when expanding existing larger urban settlements, though there are exceptions in the wider region in Figure 18 (e.g. Peterborough, Maidstone) that break this pattern.
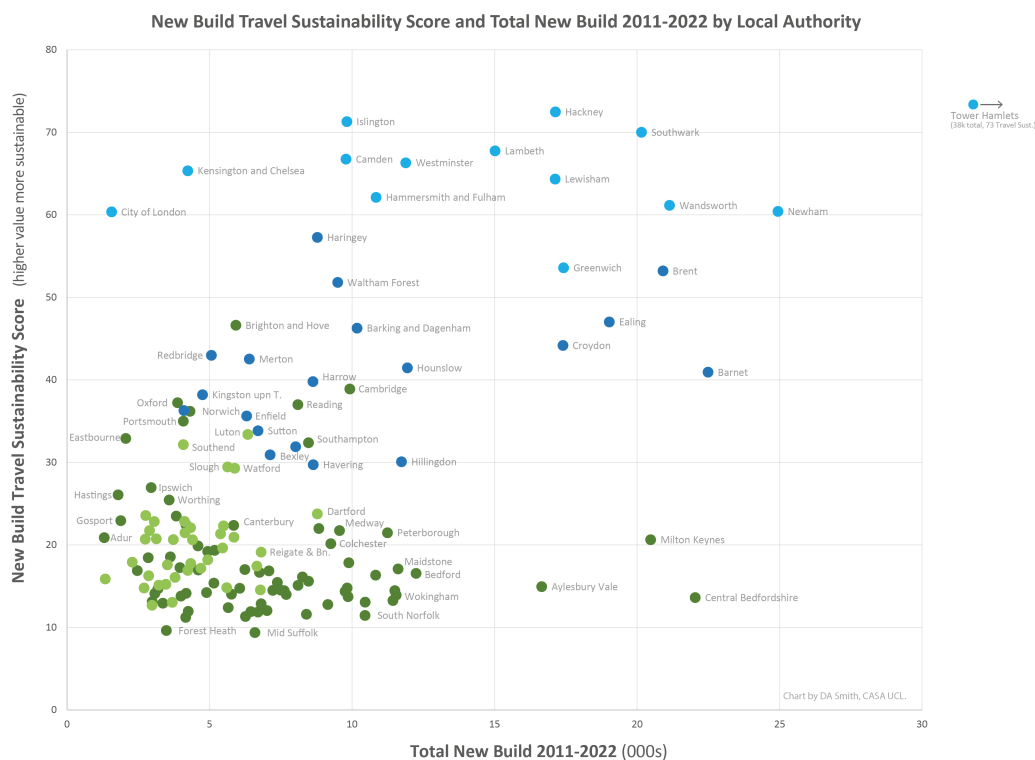

Figure 18: Travel Sustainability Score of New Build 2011-2022 and Total New Build 2011-2022 by Local Authority

The local authorities delivering high new build rates to the north west of London around Bedfordshire – Milton Keynes, Central Bedfordshire, Aylesbury Vale – perform poorly in the travel sustainability analysis. This indicates that the development that has taken place is highly car dependent, and is a disappointing result given that these were the only authorities delivering new build housing at scale outside of Greater London. These car dependent results are in line with typical

results for authorities in the Rest of the South East. Green Belt local authority results are also similar, indicating how few South East authorities have been able to avoid car dependent development.

Overall, the results emphasise the completely different planning regimes operating within the GLA compared to the wider region. While London's high-density public transport approach produces generally very sustainable travel outcomes, there is little evidence for large scale sustainable development occurring in either the Green Belt subregion or the Rest of the South East beyond a select number of towns and cities. Indeed, the overall pattern for new build for the South East is likely reducing travel sustainability over time. Overall, the results point towards a failure to create sustainable housing development at scale in the South East beyond Greater London.

5.4 Energy Efficiency Analysis

We can also use the Energy Performance Certificate data to summarise the energy efficiency of new build properties, as shown in Table 4. CO_2 emissions per dwelling are considerably lower in Inner and Outer London, with overall London emissions per dwelling around two thirds of the value for the Green Belt and Rest of the South East subregions. This is only partly due to smaller dwelling sizes, as CO_2 emissions per square metre in London are significantly lower as well, particularly for Inner London. The lower emissions in London housing can be explained by the much higher proportion of flats and the use of community heating. Three quarters of all new build in Inner London and 47% of new build in Outer London, are connected to community heating networks, delivering substantial emissions savings.

The community heating approach is only efficient for high density developments, and there are much lower proportions in the Green Belt (8%) and the Rest of the South East (5.7%). In medium and lower density developments, air and ground source heat pump technologies are a key technology for improving energy efficiency and replacing gas boilers (Wang et al., 2022). The statistics from 2011-22 are very disappointing on this front, at 4.3% of new build with heat pumps in the Green Belt and 5.9% in the Wider South East. The Green Belt authorities have the poorest outcomes on nearly all the energy efficiency metrics, which is concerning in terms of their capacity to deliver sustainable growth at scale in the future.

Table 4: Newbuild Annual Average CO_2 Emissions and Energy Summary (Data: EPC 2011-2022)

Subregion	CO_2 per Dwelling (tonnes)	CO_2 per m2 (kg)	Energy Consumption (kWh/m^2)	Community Heating %	Heat Pump % (air + ground)
Inner London	0.93	12.9	72.9	75.2	2.7
Outer London	1.04	15.3	87.2	46.9	2.8
Green Belt	1.60	18.7	106.9	7.9	3.5
Rest of South East	1.53	17.2	97.7	5.7	5.9
All Subregions (Greater South East)	1.34	16.3	92.5	27.0	4.3

The average annual CO_2 emissions by dwelling are summarised at the local authority level in Figure 19. Similar to the travel sustainability results, London boroughs generally have the most sustainable results. Town centres in the South East again are the best performing outside of London, including Cambridge, Southampton, Eastleigh, Reading, Luton, Watford, Woking and Dartford. As the chart shows average CO_2 per dwelling, there is a connection between affluence and dwelling size, with higher income boroughs such as Richmond Upon Thames and Westminster producing higher emissions. London's wealthiest borough, Kensington and Chelsea, has astonishingly high emissions

nearly twice the Inner London average. This wealth effect can also be seen in the Green Belt too, with high results for Windsor, St Albans and South Bucks.
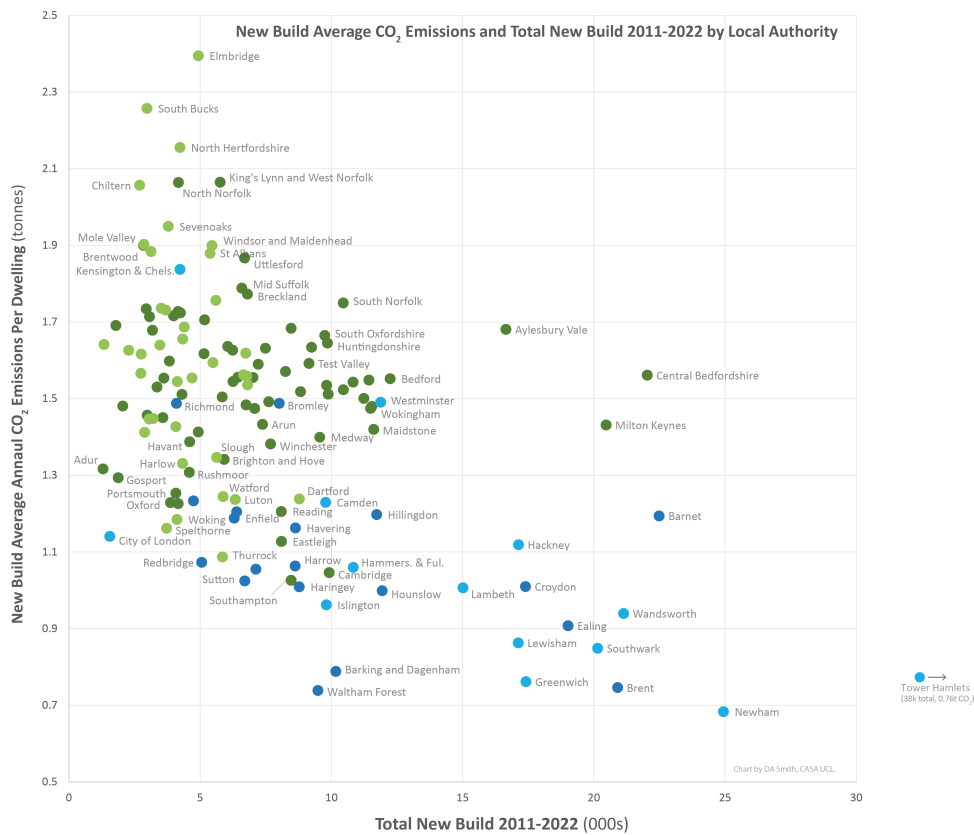

Figure 19: New Build Average Annual CO_2 Emissions and Total New Build 2011-2022 by Local Authority (note y axis starts at 0.5)

6. Conclusions

6.1 Greater London and the London Plan

The London Plan's high-density clustered approach has delivered significant growth in Inner and East London, scoring very well on travel and energy sustainability metrics. Yet overall housing volumes have been consistently short of London Plan targets for the last decade, and there is little sign this will change in the near future. In boroughs with major development sites, there has been substantial housing delivery, with impressive new build numbers in boroughs such as Tower Hamlets, Newham and Wandsworth. These high-density developments score very well in terms of travel sustainability, with new build highly concentrated in the most sustainable travel classes, further improving London's travel sustainability over time, and aligning with travel data from TfL showing improvements across the decade (Transport for London, 2022). The estimated CO_2 emissions of London's new build housing is also considerably lower than the wider region (except for affluent outliers such as Kensington and Chelsea) with three quarters of Inner London new build connected to community heat networks. These are considerable urban planning successes in the UK context.

The new build figures for Greater London are however consistently short of overall targets and affordable housing targets. Low delivery is mainly a result of low development in Outer London and low affordable housing delivery. While the select number of Outer London boroughs with Opportunity Area sites (such as Brent, Barnet and Ealing) delivered around 20k new dwellings

between 2011-2022, the rest of Outer London is generally is below 10k, and the lowest boroughs (Redbridge, Richmond, Kingston) below 5k. This is a major factor in London consistently failing to reach London Plan targets at any time during the last decade. Strategies to increase development in Outer London could include the densification of Outer London centres, and the location of more future Opportunity Area sites in Outer London. The latter requires continued public transport investment to release sites, such as the proposed Crossrail 2, which would release development sites in north and south-west London, and orbital transport links similar to recent Overground and tram network improvements (Mayor of London, 2018). Green Belt land restrictions are also very important for Outer London development, where 27.4% of total land is in the Green Belt (DLUHC, 2023c).

Low affordable housing delivery has also contributed to the failure to meet housing targets, at exactly the time the affordability crisis has been at its most severe. Affordable housing delivery fell dramatically in the years following the 2009 financial crash and the subsequent period of austerity. There is huge range in affordable housing delivery at the local authority level, from above 50% in Waltham Forest and Barking and Dagenham, to below 25% in Barnet and Wandsworth, and woefully low results for Hammersmith and Fulham (12%) and the City of London (6%). There is certainly scope for greater enforcement of affordable housing targets across all London boroughs. The current Mayor of London has responded to affordable housing shortages by establishing a new target for 50% genuinely affordable housing, and negotiating central government funding, leading to greatly increased affordable housing starts in 2022 and 2023, with high proportions of social housing (Mayor of London, 2023). If sustained for the coming decade, this will make a substantial difference in affordable housing supply. In terms of overall delivery however, the pandemic and high interest rates have greatly reduced market housing starts (Greater London Authority, 2022), meaning overall housing targets will continue to be missed for at least the short term.

6.2 The Green Belt and Wider Region

The analysis has provided several indicators that London's Green Belt needs reform. Firstly, the house price analysis shows that housing markets are strongly integrated between Green Belt local authorities and Outer London, and that there is a close spatial alignment between higher prices and the Green Belt boundary, in line with studies finding that Green Belt policy is pushing up prices (Cheshire and Buyuklieva, 2019; Mace et al., 2016). Green Belt authorities had low housing delivery in the last decade – drastically lower than London boroughs, and also significantly lower than authorities in the Rest of the South East. Although this outcome is to be expected given development restrictions, Green Belt policy has been applied very inflexibly, with only 1.4% of the London region's Green Belt land released between 2011 and 2022 (DLUHC, 2023c). There is a clear rationale for changing the rigid Green Belt policy in the National Planning Policy Framework (Mace, 2018). Green Belt restrictions are affecting both the wider region and Outer London boroughs.

In addition to constraining supply, the Green Belt does not perform well in terms of travel sustainability or energy efficiency metrics. Green Belt authorities are largely car dependent in the 2021 data, with very similar travel behaviour results to the Rest of the South East. The exceptions are in town centres such as Luton, Guildford and Watford. Arguably the Green Belt restrictions are themselves preventing towns from growing and reaching economies of scale in public transport and active travel (the benefits of which can be seen in South East centres such as Reading and Norwich). Furthermore, the Green Belt appears to be displacing development, with a ring of car dependent low-density housing identifiable just beyond Green Belt boundary.

6.3 Green Belt Reform and Sustainable Development

This analysis agrees with research advocating Green Belt reform (Mace, 2018). Travel sustainability conditions are needed to avoid this reform producing highly car dependent housing, such as has been occurring in Central Bedfordshire and Milton Keynes (where the East-West rail line should have been built much earlier). Pedestrian access to rail stations is a sensible starting point for prioritising Green Belt land for housing (Cheshire and Buyuklieva, 2019; Mace et al., 2016), and the analysis here generally found a spatial match between rail infrastructure and better travel sustainability outcomes. Proximity to rail stations is not however sufficient to produce sustainable travel in the Green Belt subregion, and the aim should be for new housing to have local access to a range of services (e.g. retail, schools), providing sustainable travel options for multiple trip types. Another related issue is the need for more sustainable medium density housing. There is little evidence in the EPC data for adoption of key medium-density housing technologies such as heat-pumps and solar PV, while very high prices for terraced and detached housing reflect clear demand for these housing options.

Green Belt reform would need to come from national government, changing the very restrictive current National Planning Policy Framework to allow authorities with housing shortages to develop Green Belt land of low environmental quality near services, and to benefit from the land value uplift to develop further services and affordable housing (Mace, 2018). It would be logical to give powers to the GLA (and potentially other combined authorities) for the strategic coordination of this development within its boundaries, given the GLA's strong track record on sustainable housing delivery. It is difficult however to envisage large scale change happening in the South East without national government also organising improved regional coordination and planning (Bowie, 2017). This analysis identifies better travel sustainability outcomes for new build in larger towns and cities in the South East, and in those with stronger high-density centres. This evidence supports the urban extension model for development in the Green Belt. There are many candidate towns in London's Green Belt for urban extensions, including Luton, Guildford, Watford, Maidenhead, Hemel Hempstead, Chelmsford, Basildon, Reigate and Harlow. This larger scale solution is politically more challenging, and would again require leadership and coordination from national government.

7. Acknowledgements

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