ARUP

Greater London Authority

West London Local Area Energy Plan – Phase 1

Subregional Output Report

July 2023

Contents

Glossary

Abbreviation	Expanded Term	Definition
DESNZ	Department for Energy Security & Net Zero	A department of His Majesty's Government established in February 2023 responsible for the security of energy supply, ensuring properly functioning energy markets, encouraging greater energy efficiency and seizing the opportunities of net zero to lead the world in new green industries.
DfT	Department for Transport	A department of His Majesty's Government responsible for the English transport network and a limited number of transport matters in Scotland, Wales and Northern Ireland that have not been devolved.
DNO	Distribution Network Operator	Company that operates the power distribution network infrastructure in a specific area.
DSO	Distribution System Operator	Company responsible for managing and optimising the flow of electricity within a distribution system.
DSR	Demand-side response	Involves the shifting or shedding of peak electricity demand in response to power markets, in exchange for financial incentives for customers.
ENA	Energy Networks Association	A not-for-profit industry body funded by UK gas and electricity transmission and distribution operators.
EPC	Energy Performance Certificate	A certificate that gives an indication of how energy efficient a property is. It includes an energy efficiency rating (A to G – highest to lowest efficiency respectively), a summary of a property's energy performance features, and recommendations for improvements.
EV	Electric Vehicle	A vehicle that is fuelled by electricity.
GLA	Greater London Authority	Regional governance body of Greater London.
GNO	Gas Network Operator	Company that operates the natural gas distribution network infrastructure in a specific area.
LSOA	Lower Layer Super Output Area	A geographic hierarchy designed to improve the reporting of small area statistics in England and Wales. Typically contain four to six OAs.
LAEP	Local Area Energy Plan (or Planning)	A pioneering planning approach which addresses the whole energy system, to deliver an evidence-base for change and set-out a plan for implementation.

Glossary

Abbreviation	Expanded Term	Definition
LEAR	Local Energy Asset Representation	A visual baseline of energy assets within a local area, typically covering energy demand, generation, storage & distribution assets, energy network constraints, social factors (e.g. fuel poverty statistics). LEAR's provide an evidence base to help inform development of a LAEP.
MVA	Megavolt amperes	A unit used to measure apparent power, which is the total current and voltage in an electrical circuit.
NGET	National Grid Electricity Transmission	The body responsible for owning and maintaining the high voltage electricity network in England and Wales.
NGESO	National Grid Electricity System Operator	The electricity system operator for England, Scotland and Wales.
OA	Output Area	A geographic hierarchy designed to improve the reporting of small area statistics in England and Wales. OAs are the lowest level of geographic area used for statistics.
Ofgem	The Office of Gas and Electricity Markets	The government regulator for the electricity and downstream natural gas markets in Great Britain.
OPDC	Old Oak and Park Royal Development Corporation	Mayoral Development Corporation established to secure the regeneration of the Old Oak Opportunity area, spanning across three London boroughs – Brent, Ealing and Hammersmith & Fulham.
Solar PV	Solar Photovoltaics	Converts solar radiation into electricity using photo-voltaic (PV) cells.
SSEN	Scottish & Southern Electricity Networks	A distribution network operator for electricity covering Central Southern England (including a portion of West London) and the North of Scotland.
TOUT	Time-of-use tariffs	Flexible electricity tariffs which differ between time of the day based on energy availability and generation.
UKPN	UK Power Networks	A distribution network operator for electricity covering South-East England, East of England and London.

Executive summary

This report sets out the results of Phase 1 of the West London Local Area Energy Plan project, which comprises a baseline local area energy representation for the nine West London boroughs, Brent, Barnet, Ealing, Hammersmith and Fulham, Harrow, Hillingdon, Hounslow, Richmond-Upon-Thames and Wandsworth, as well as the Old Oak and Park Royal Development Corporation (OPDC). The report was prepared by Arup for the West London Energy Planning Partnership.

Key findings

The electricity distribution and transmission grid in West London is under significant pressure. The sub-region is home to a higher than typical density of data centres and redevelopment, which have reserved much of the future available power capacity. This may have implications for the phasing of the delivery of housing in affected West London boroughs (in particular Hounslow, Hillingdon and Ealing). Local Planning Authorities need to ensure their housing trajectories adequately demonstrate delivery, as aspect that will be assessed by Planning Inspectors at examination.

As well as the significant anticipated growth in the sub-region that will add to the need for power, the constraints issue is compounded by Net Zero targets and the Mayor's chosen Accelerated Green Pathway, which aims for rapid and mass electrification of heating and transport across London.

Net Zero targets and growth ambitions will not be met without urgent and radical action. The GLA is working to drive change and access available power, but significant effort is needed to reduce the current demand and invest in local generation and new solutions offering flexibility.

Project aims

The West London LAEP project aims to help stakeholder organisations to:

- Support housing delivery
- Plan a future energy system that supports low carbon heating (including heat networks and individual building solutions), decarbonisation of transport and renewable energy generation
- Support a major step change in the energy efficiency of buildings
- Facilitate and visualise the energy transition, identifying constraints and risks
- Enable development by relieving capacity constraints on local power networks
- Mobilise investment into strategic electricity infrastructure reinforcement
- Facilitate data sharing and collection for robust and streamlined evidence gathering
- Establish an evidence base for boroughs to leverage in the development of their LAEP.

This Phase 1 has been delivered as a single exercise serving the whole of the West London area. Phase 2 comprises the full LAEP with action plan for the local area, and is planned to be carried out as separate borough-level exercises.

This report identifies the main findings from this data gathering and transformation exercise, drawing on them to develop a series of recommendations for further cross-cutting, sub-regional actions, as well as borough specific actions, as in Appendix B.

Further details of the local energy system can be found on the West London LEAR Online Platform, produced as part of this project.

More detail on grid constraints can be found in the GLA's 'West London Electricity Capacity Constraints update - June 2023' document.

Executive summary

The current picture

West London is comprised mostly of residential, as well as significant commercial and industrial areas. Data shows that 80% of areas in West London have an average EPC rating of D, with only relatively few areas achieving an average rating of C or above. For non-domestic buildings, D is also the dominant average EPC category.

Based on building level energy modelling, generally commercial and industrial buildings consume the most electricity, whilst residential buildings consume more heat. Around 95% of existing buildings are heated by natural gas.

For transport, 80% of driven miles are attributed to private cars, only a negligible proportion of these journeys are with Electric Vehicles (EVs).

West London's electricity network is operated by two distribution network operators (DNOs): UK Power Networks (UK Power Networks) and Scottish and Southern Electricity Networks (SSEN). Both license areas have capacity constraints, on specific substations, and there are constraints on the National Grid transmission network and Grid Supply Points (GSPs) too.

In West London, data centres alone account for a substantial proportion electricity consumption, representing 18% of total demand. There are 22 known data centres with a total of 273 MW of IT load distributed across Brent, Ealing, Hillingdon and Hounslow, with at least three existing and four new data centres in OPDC. Data centres' represent a significant opportunity for the decarbonisation of heat.

The future picture

Over 200,000 homes and 3.5m m^2 of new commercial floor space are projected by 2043 in the sub-region, which represents significant new demand for power (see overleaf).

For existing building stock, two modelled building retrofit scenarios were undertaken: deep and shallow. In each scenario, different levels of retrofit intervention have been applied. In general, shallow interventions could be actioned with minimal disruption to the building use / operation. Deeper retrofit interventions are more costly and may require the building to be vacant in order to undertake the works and in residential applications, may save up to 65% of the heat demand.

Under the Mayor's Accelerated Green Scenario, which targets rapid electrification of heat and transport, the power demands of the West London sub-region are expected to grow by at least 4,000MVA. With lower levels of building retrofit or less efficient new development, this could be much higher.

The chart overleaf shows the future demand for power attributed to the needs of new development, electric vehicles, existing buildings and new data centres. Two scenarios for the demands of new development are shown, indicating the size of the opportunity to reduce the power needs of new buildings. The graph compares the stacked demands against the 2023 available spare capacity (headroom), indicating the scale of reinforcement required.

The data presented in this report is based on the most up to date information available at the time of writing. The content presented is designed to give an indication to the type of challenges present in West London. As areas progress and complete their Local Area Energy Plans, this exercise should begin with checking that data is up to date, and in particular to engage with DNOs to ensure that this is true.

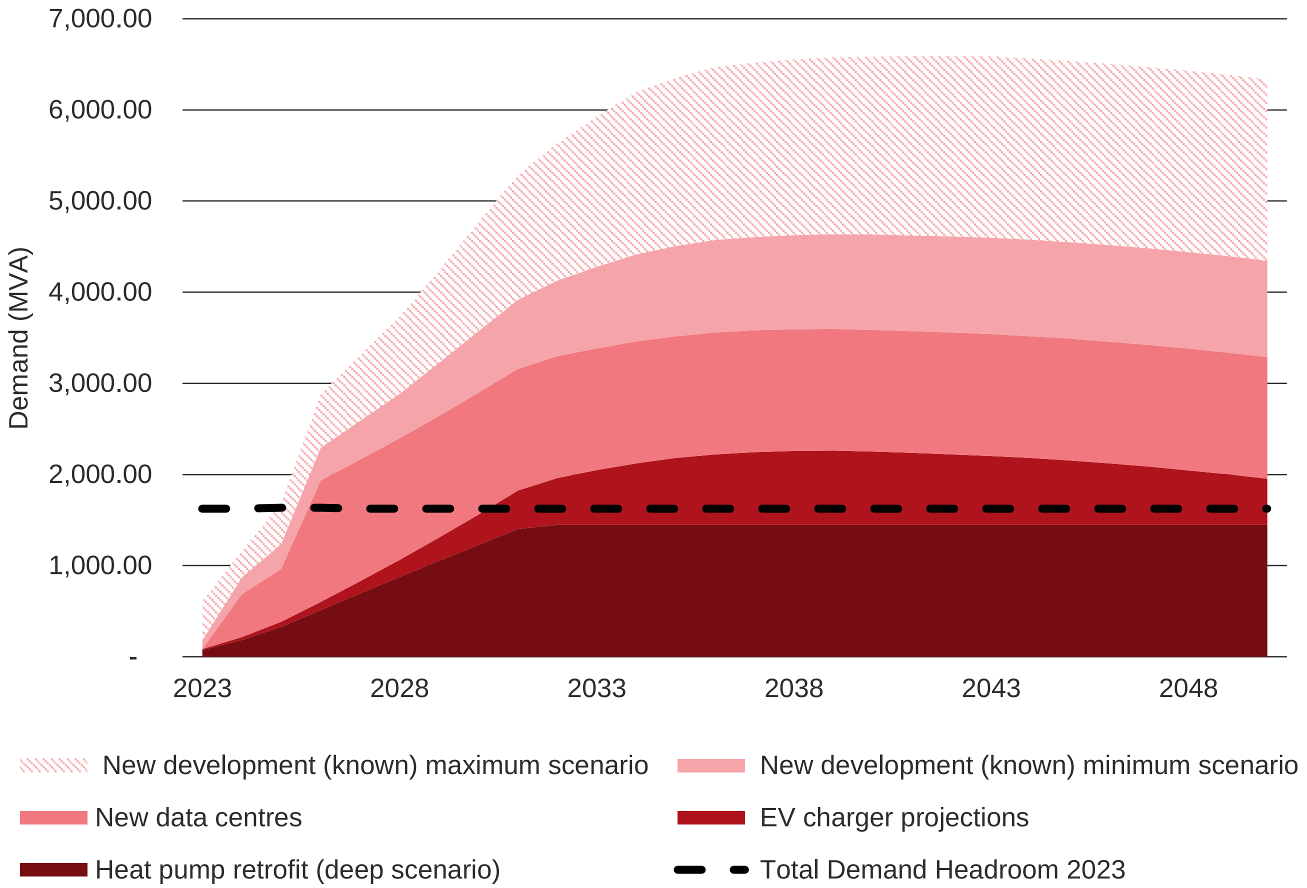
Executive summary

Next steps

A series of next steps have been provided across seven thematic areas: Electricity network reinforcement, energy system flexibility, decarbonise heat, energy efficiency upgrades in buildings, maximise local renewable generation, decarbonise transport and decarbonise major energy users.

Some of these actions are common across the sub-region, for example studies that look at the role of data centres, the role of thermal energy storage or how Low Voltage considerations could be taken into account.

Other actions are bespoke to the borough, and highlight context-specific barriers and opportunities relevant to the local area.



Chapter 1: Introduction

1. Introduction
Objectives of the work

This report summarises work undertaken by Arup on behalf of the West London Energy Planning Partnership, comprised of the GLA and West London boroughs to build the evidence base for further Local Area Energy Planning across the West London sub-region, helping each borough plan for meeting its own Net Zero targets and climate objectives for energy demand, supply and distribution.

Organisations covered by the West London Energy Planning Partnership include:

- West London boroughs: Barnet, Brent, Ealing, Hammersmith and Fulham, Harrow, Hillingdon, Hounslow, OPDC, Richmond and Wandsworth
- GLA
- Cadent
- UK Power Networks
- Scottish Southern Electricity Networks (SSEN)
- National Grid

The project aims to help stakeholders:

- Realistically the pace delivery of their Local Plans
- Plan a future energy system that supports low carbon heating (including heat networks and individual building solutions), decarbonisation of transport and renewable energy generation
- Support a major step change in the energy efficiency of buildings
- Facilitate and visualise the energy transition, identifying constraints and risks
- Enable development by relieving capacity constraints on local power networks
- Mobilise investment into strategic electricity infrastructure reinforcement
- Facilitate data sharing and collection for robust and streamlined evidence gathering

The project has used engagement, data collection and technical analysis to:

1. Visualise and host data online to enable future LAEP development in all nine boroughs (see overleaf)
2. make targeted recommendations to each of the nine boroughs
3. Make cross-cutting recommendations for ongoing sub-regional work programmes

The steps that have been taken are summarised in Figure 1.1.

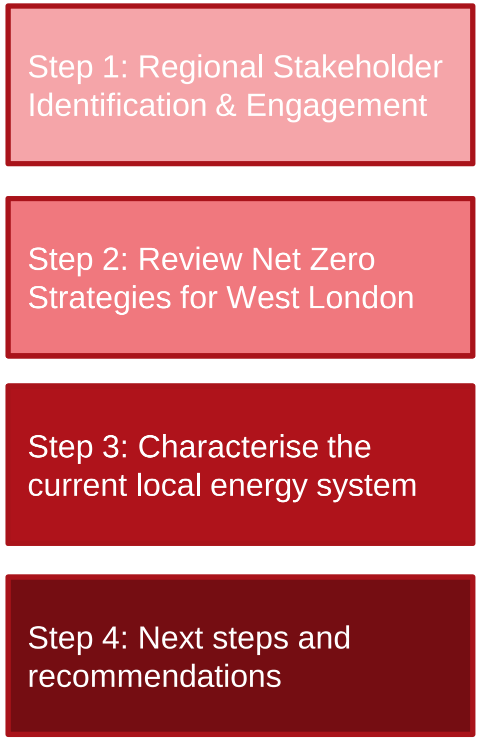


Figure 1.1: Steps taken in the work undertaken by Arup on behalf of the West London Energy Planning Partnership.

1. Introduction
Study overview

Step 1: Regional stakeholder identification and engagement

This workstream has been cross-cutting throughout the project, largely comprised of:

- Mapping stakeholders across the energy sector, in the public and private spheres
- Raising awareness for the project, for example through the launch event and workshops
- Meeting priority stakeholders on a one to one basis to understand their objectives and priorities, as well as what information they have that could feed into the project
- Gathering data, and cross-checking our understanding of datasets with owners
- Convening stakeholder groups and making connections

Step 2: Review net zero strategies for West London

A review of existing policy and strategy documents across the nine boroughs, the GLA, OPDC, Ofgem and the UK government was carried out. This included an assessment of the key priorities, actions and targets relating to key sectors including:

- Residential buildings
- Commercial & industrial buildings
- Infrastructure
- Transport
- Energy generation and supply

as well as an indication of the status of these actions/targets (e.g. proposed, adopted, live) and their impact on the completion of the Local Area Energy Plan.

Step 3: Characterise the current local energy system

The earlier stages of this project culminated in creation of the Local Energy Asset Representation (LEAR) tool, which is an ArcGIS Experience Builder based platform hosted by the GLA. This tool is a digitised form of what would usually be a pdf LEAR report, in accordance with the Energy Systems Catapult methodology.

The standard LEAR format has been developed to include some additional energy system elements in line with the data collection required for the LAEP methodology. The LEAR tool visualises this data and allows the user to interact with and download the content.

The information captured in the LEAR tool can be used as a foundational dataset for carrying forward the recommendations given in this section. It should be noted that the data in the LEAR tool is up to date at the time of writing, however, will need to be maintained to remain up to date as new datasets become available, which the GLA aims to do at six monthly intervals.

Step 4: Next steps and recommendations

This stage focused on exploring how the local energy system might change in the future. Two energy efficiency retrofit scenario were considered to reduce demand in the existing building stock. Future energy demands for residential, non-residential, and data center developments were modelled based on borough planning data. Transport demand projections accounted for mode shift and electric vehicle adoption. This stage also examined options for transitioning to a net-zero energy system, including capturing network constraints as well as planned energy infrastructure development, potential waste heat sources, and solar PV generation.

These projections are captured within the LEAR tool and can be used as a first step in identifying sub-regional and borough-specific focus areas for exploring options of decarbonising the local energy system. Initial recommendations are summarised in Chapter 4 of this report.

Chapter 2: Current picture

2. Current picture
Region overview

West London is the second largest economic region in the UK and is an emerging leader in sustainability and clean technologies that will help deliver Net Zero.

With ambitious targets for residential and commercial growth, it is also home to Heathrow Airport and other major transport infrastructure, a high concentration of data centres, and power networks in need of substantial reinforcement to meet growth and decarbonisation targets.

In line with the Mayor's chosen Accelerated Green Pathway[1], heating and transport energy demands – currently met by fossil fuels – are expected to be largely electrified. Combined with the growth anticipated, the local energy system in West London is facing significant pressure.

The West London sub-region is diverse and varied, with some of the most, and the least deprived areas in the UK. Fuel poverty levels vary dramatically, with many areas exceeding the national average of 13.4% - see Figure 2.1.

To help address this disparity and reduce fuel poverty, whilst ensuring resilience of the future wider energy system, there is a strong need for energy efficiency improvements in homes – the opportunity for which is explored later.

[1]Pathways to Net Zero Carbon, GLA, January 2022

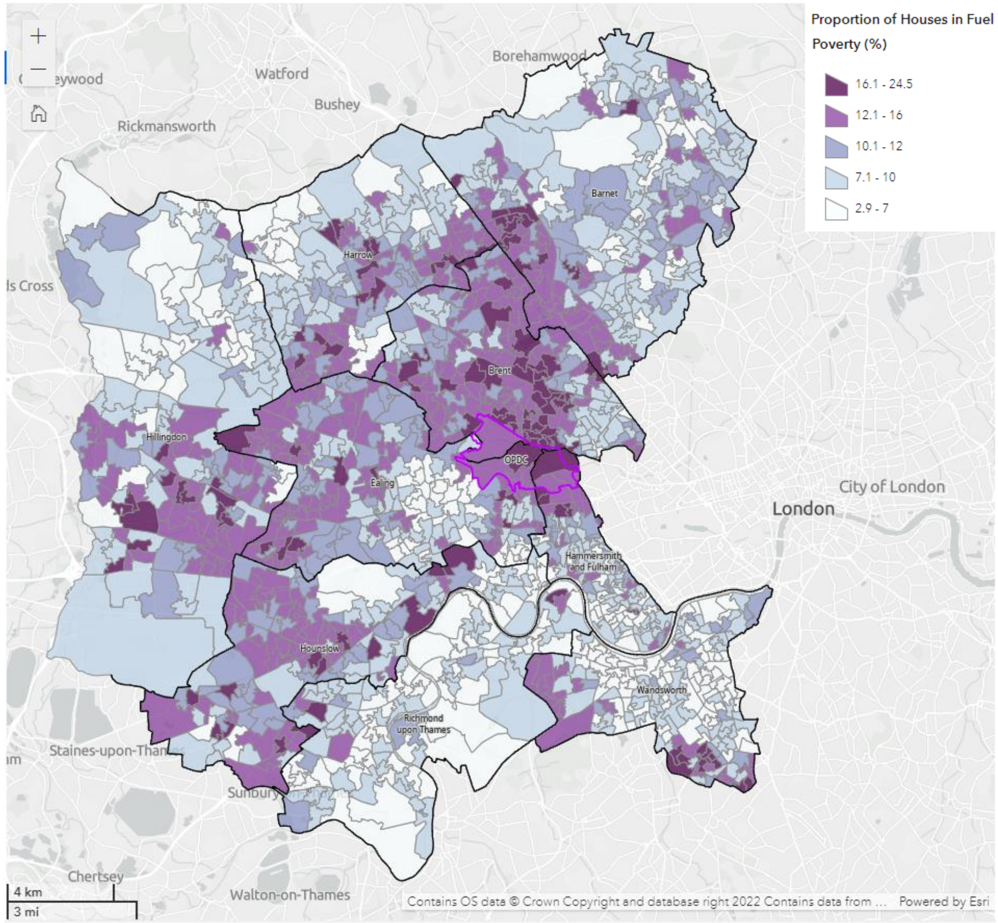


Figure 2.1: Proportion of houses in fuel poverty by LSOA. Source: Sub-regional fuel poverty data, 2022, DESNZ.

2. Current picture
Net zero plans and initiatives

A policy and strategy review was undertaken which included all nine boroughs, OPDC, GLA, utilities, Ofgem and the UK Government. This included an assessment of policy gaps in relation to the major elements of a future low carbon whole energy system, and sought to capture existing investment and development plans for energy infrastructure such as planned data centres, renewable generation or heat networks.

The targets set out by the Greater London Authority (GLA) infer that all boroughs must be Net Zero Carbon emissions across all operations by 2030. Almost all West London boroughs reflect this in their own targets, strategies and commitments, with the exception of Barnet, Hounslow and Wandsworth.

The level and pace of change required in the energy system to meet these targets is significant, and will require interventions across a number of areas. The Mayor has already chosen the Accelerated Green Pathway to reach the London-wide targets, which is used as the base case for this study as most boroughs align with that target. However, individual boroughs will have their own specific circumstances and local context that may mean their pathway deviates from Accelerated Green pathway. See Chapter 4 for further next step recommendations.

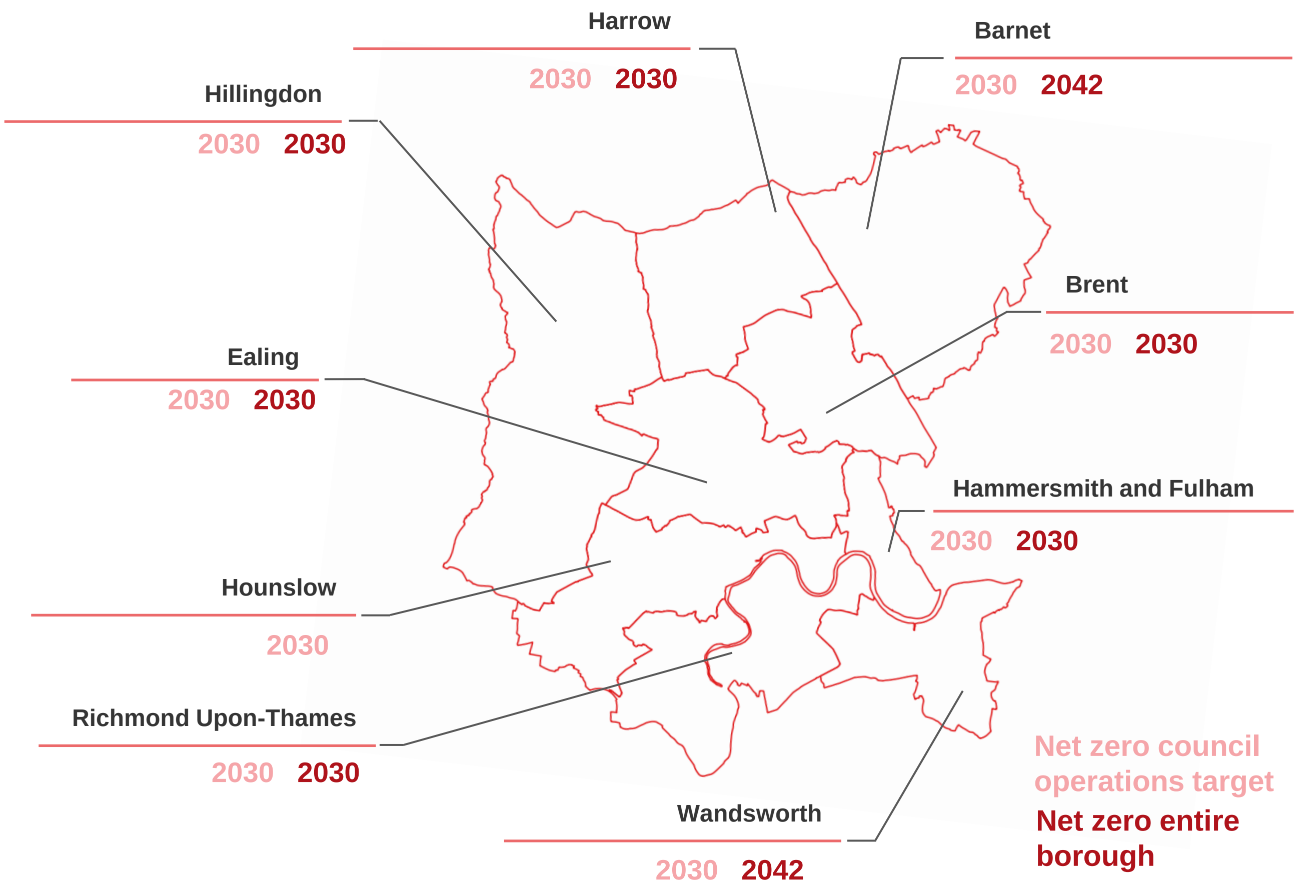


Figure 2.2: Council operations and borough wide net-zero targets in West London. Source: Boroughs' most recent Climate Action Plans as of 2022.

2. Current picture
Buildings landscape

West London comprises large areas of residential properties as well as significant commercial and industrial areas.

By floor area, generally residential makes up the largest proportion of use class (93%). However this varies; for example in Hillingdon, commercial and public buildings comprise a larger proportion of the total buildings stock, where offices alone constitute 40% of the total floor area.

Figure 2.3 also demonstrates the large presence of industrial areas in certain parts of West London, in particular Brent, Ealing, Hillingdon and Hounslow, where industrial classes constitute more than 10% of total floor area.

The figures overleaf show the composition of Energy Performance Certificate (EPC) ratings across West London by output area (OA).

This data shows that 80% of OAs in West London have an average residential EPC rating of D, with only relatively few areas achieving an average rating of C or above. For non-domestic buildings, D is also the dominant average EPC category, mapped by OA overleaf.

It is noted that EPC ratings, beginning with residential properties, are set to increase based on government and mayoral policy updates, so these metrics are predicted to improve.

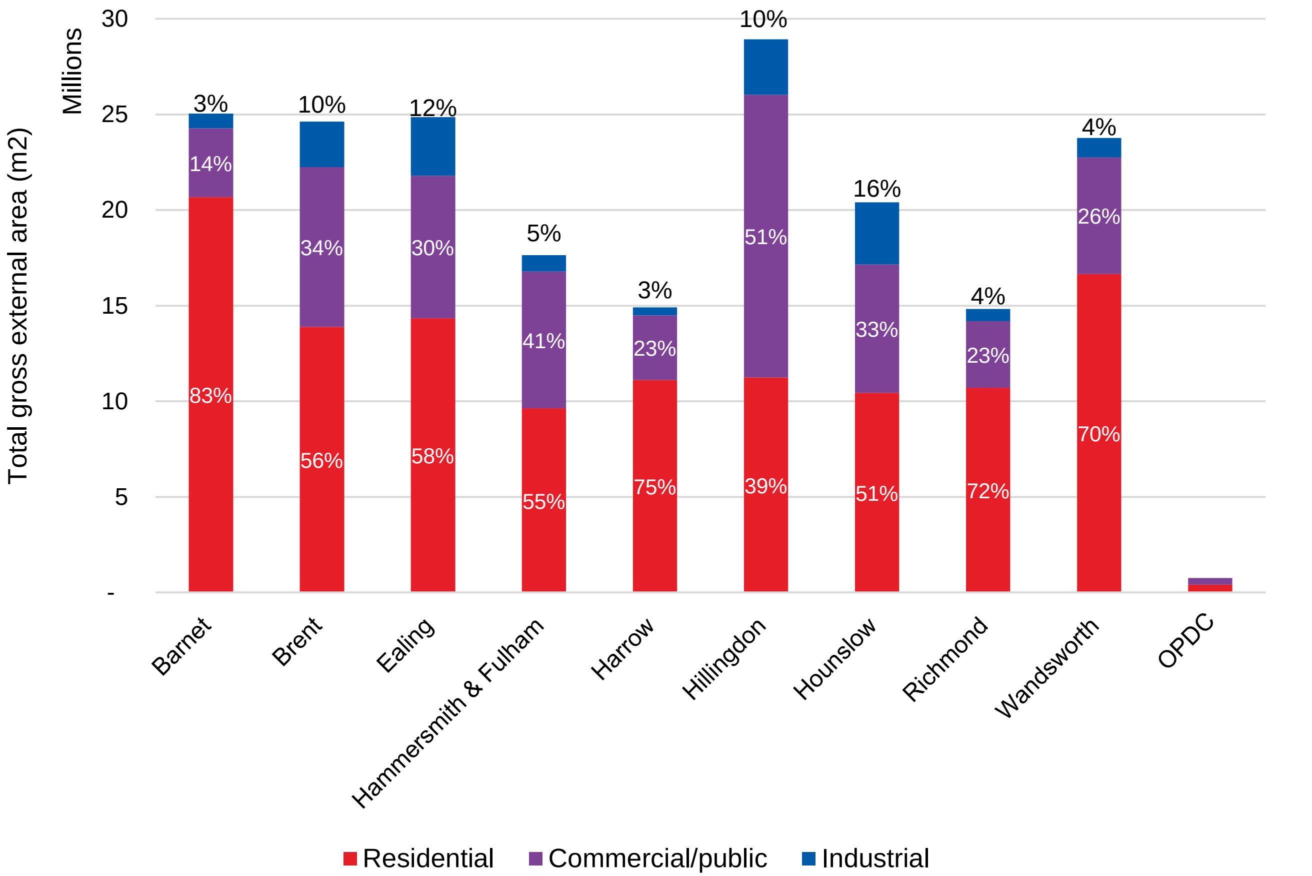


Figure 2.3: Total floor area distribution for the nine West London boroughs and OPDC in 2022. Source: Arup & Skenario Labs analysis based on Ordnance Survey data.

2. Current picture
Buildings landscape

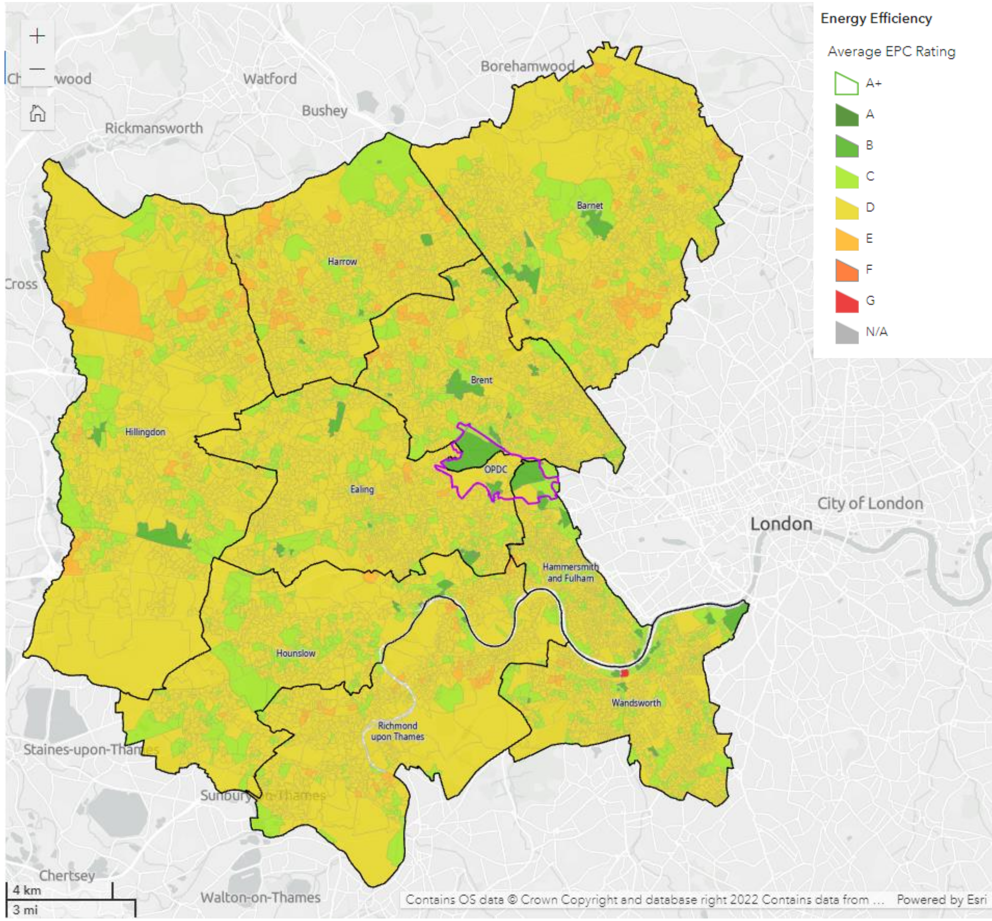


Figure 2.4: Average EPC rating by OA for domestic properties. Source: Energy Performance of Buildings Data: England and Wales, 2022, Department of Levelling Up, Housing & Communities. Results may be affected by the presence of open space

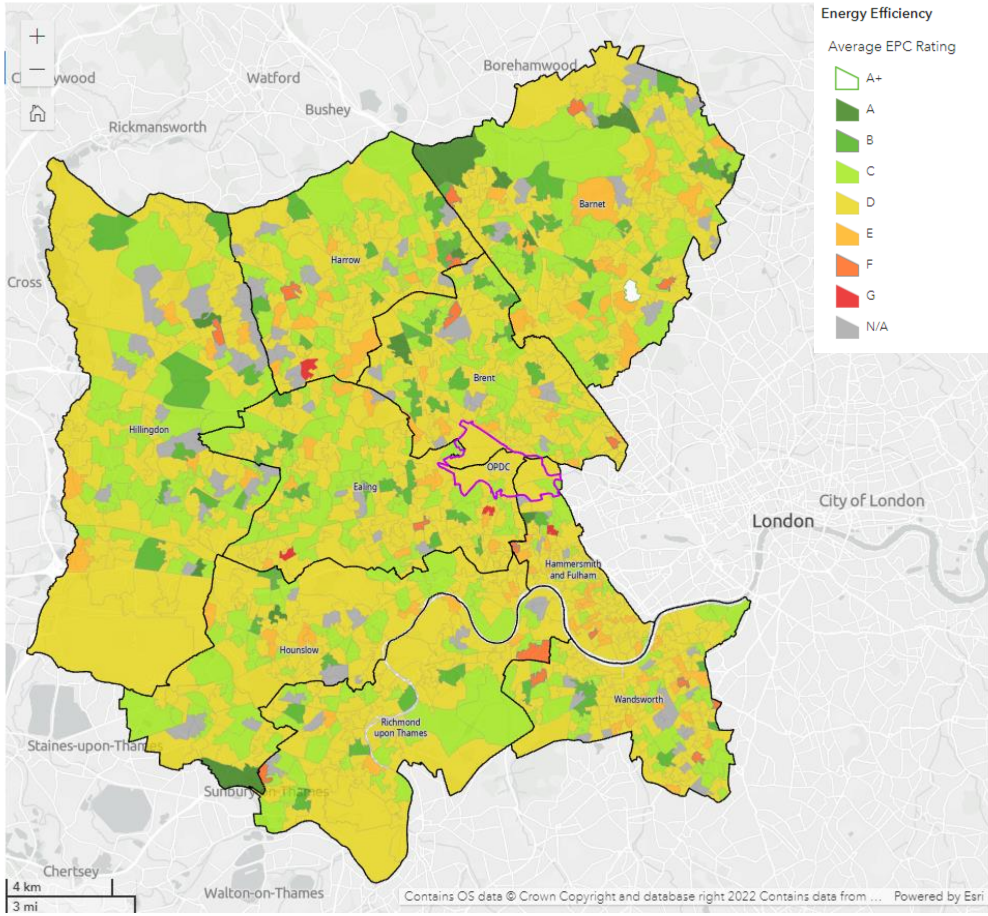


Figure 2.5: Average EPC rating by OA for non-domestic properties. Source: Energy Performance of Buildings Data: England and Wales, 2022, Department of Levelling Up, Housing & Communities. Results may be affected by the presence of open space

2. Current picture
Energy consumption

Electricity consumption

The graph adjacent shows the total annual electricity consumption of each building type for each of the nine boroughs and OPDC, as calculated for every building in the area, and aggregated up to borough level.

The distribution of these different categories varies significantly between different boroughs – in Barnet residential properties dominate electrical demands, with a very small share arising from industrial buildings. In contrast, commercial and public buildings in Hillingdon constitute 69% of total electricity demand, compared to just 20% from residential.

The higher relative energy intensity of commercial, public and industrial buildings is clearly reflected when comparing this figure with the floor areas shown on page 14, evident by the higher proportion of total electricity demand from these categories compared to their floor area share.

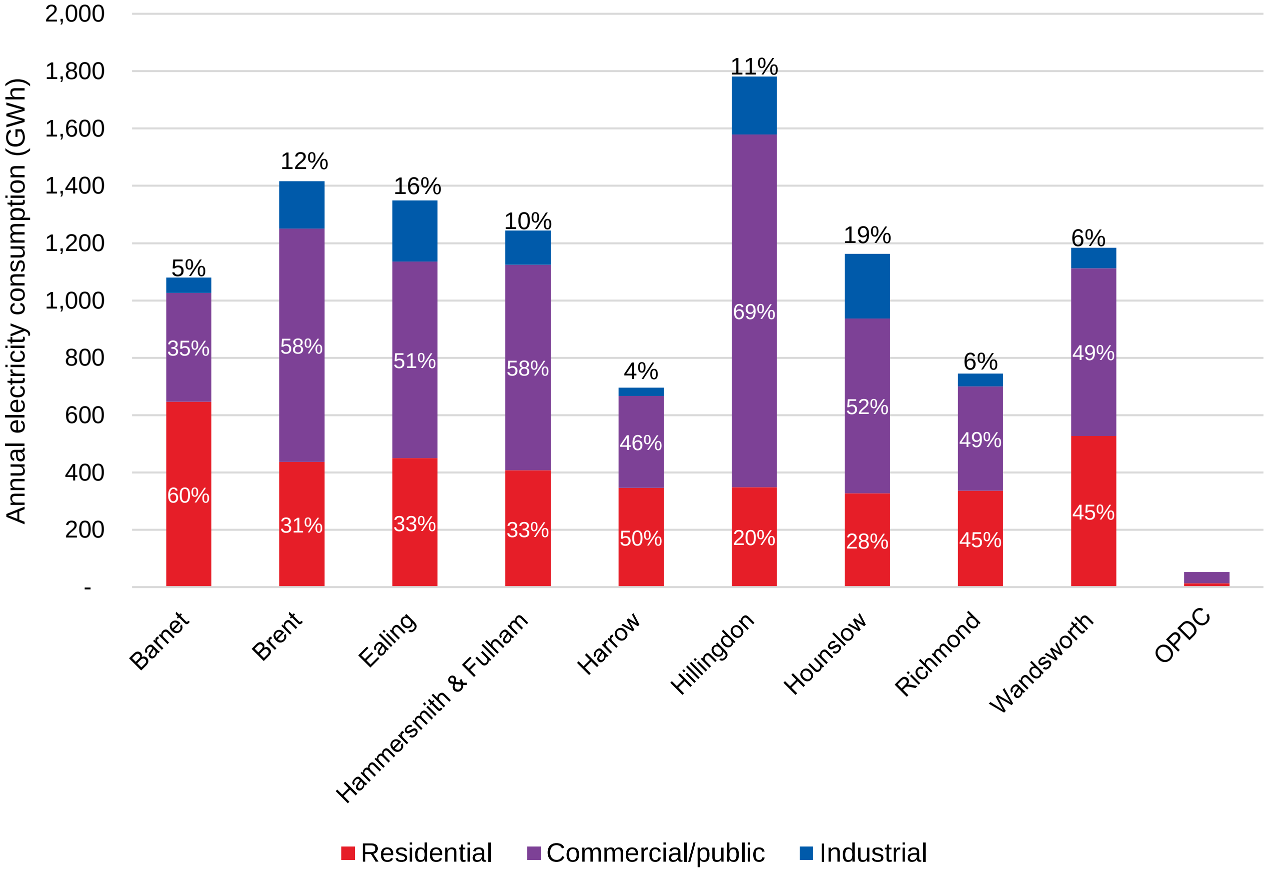


Figure 2.6: Annual electricity consumption distribution for the nine West London boroughs and OPDC in 2022. Source: Arup & Skenario Labs analysis based on Ordnance Survey data.

2. Current picture
Energy consumption

Heat consumption

The graph adjacent shows the industrial, commercial and residential annual heat demands in GWh for boroughs in West London.

As opposed to electricity demand, which is dominated by commercial buildings, residential properties constitute the largest portion of heat demand across all boroughs, followed by commercial and industrial buildings. Overall, the residential heating demand seen in each borough is consistent with the overall number of homes, with Barnet, Ealing and Wandsworth showing the greatest demand.

Approximately 95% of buildings are currently heated by natural gas, which will need to switch to a low-carbon heating source in order to meet the area's decarbonisation targets. This will pose a significant challenge, especially in properties which are not owner-occupied, and where current building performance, condition and construction inhibits the use of a heat pump.

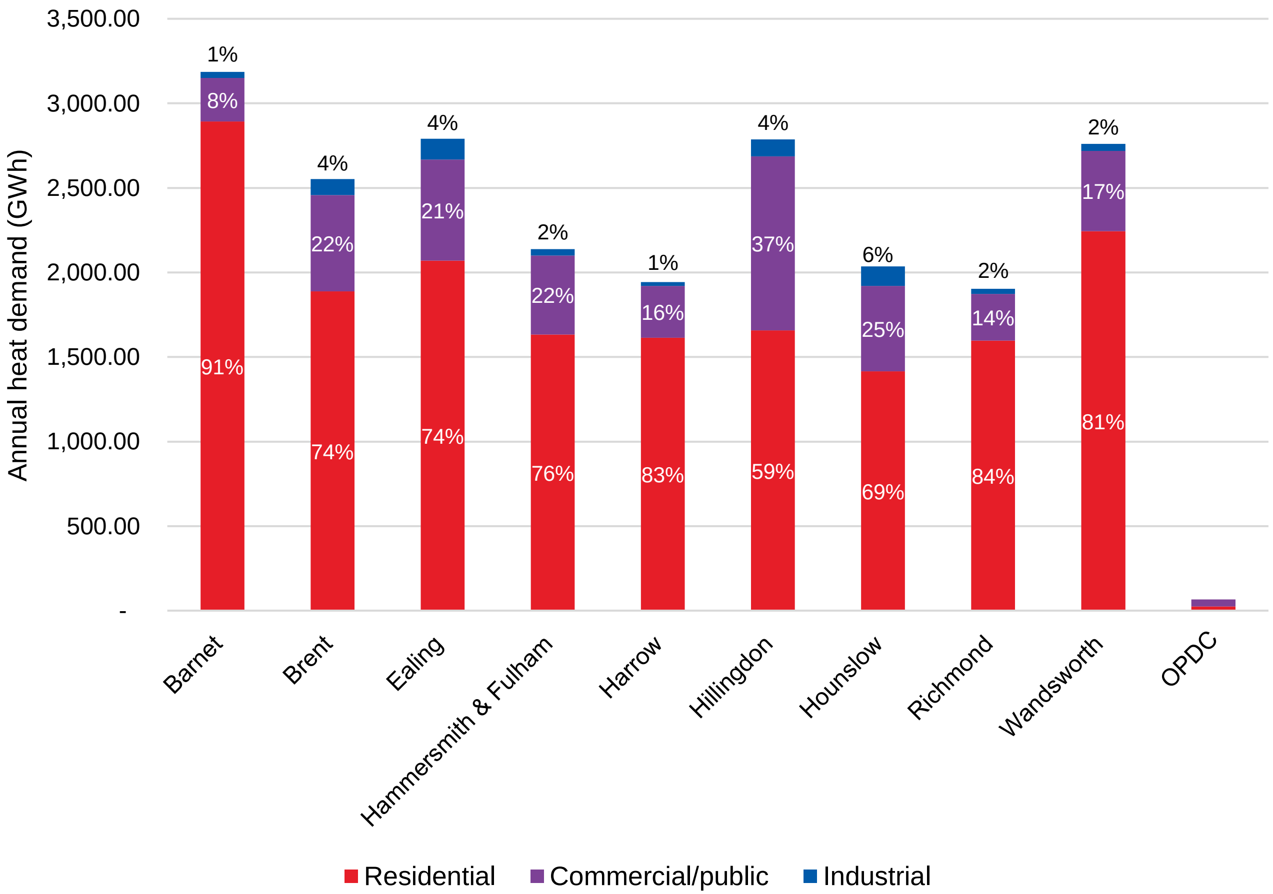


Figure 2.7: Heat consumption across the nine West London boroughs and OPDC in 2022. Source: Arup & Skenario Labs analysis based on Ordnance Survey data.

2. Current picture
Energy consumption

Transport energy consumption

In 2019, around 6,800 million miles were driven by cars, Light Commercial Vehicles (LCVs) and Heavy Goods Vehicles (HGVs) in the West London sub-region. Cars make up the largest proportion of these journeys at over 80% of total distance travelled, while HGVs constitute 3%.

Most of the fuel consumed by transport is petrol and diesel, with an almost negligible proportion currently supplied using electricity, as shown in Table 2.1. Hammersmith and Fulham has the largest share of its current transport demand supplied by electricity, which is consistent with the large number of EV chargepoints already present in this borough according to the National Chargepoint Registry, shown in Figure 2.8.

Figures 2.10 and 2.11 overleaf show the total mileage and current EVs by borough. Homes chargers are not shown. As would be expected, boroughs with a larger geographic area typically have a higher vehicle mileage and a greater number of EVs.

The variation between the two maps for certain boroughs highlight where EVs make up a higher or lower share of total mileage than for others, (e.g., a lower proportion in Hounslow and higher in Hammersmith and Fulham.).

Note that TfL bus depots and other facilities are excluded from this analysis.

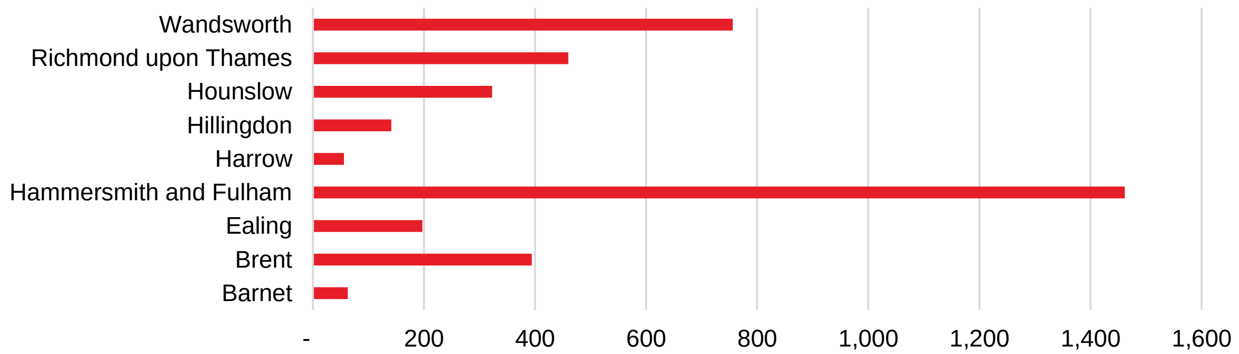


Figure 2.8: Number of existing electric vehicle chargepoints. Source: National Chargepoint Registry, 2022.

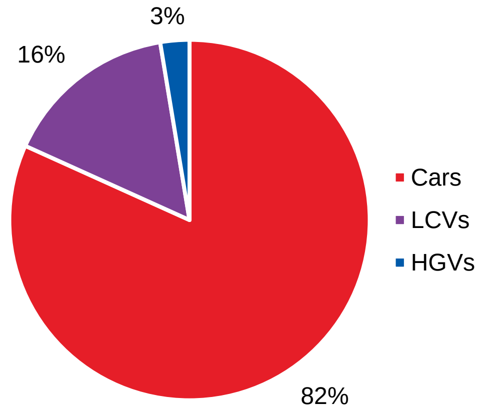


Figure 2.9: Vehicle mileage split across West London. Source: Road traffic statistics (TRA), 2022, DfT.

GWh / annum	Electricity	Other fuel
Barnet	2.9	1,280
Brent	1.7	656
Ealing	2.2	913
Hammersmith and Fulham	1.7	366
Harrow	1.1	469
Hillingdon	3.1	1,350
Hounslow	2.8	977
OPDC		
Richmond	1.2	42
Wandsworth	1.6	544

Table 2.1: Energy consumption in transport for the nine West London boroughs and OPDC. Source: London Energy and Greenhouse Gas Inventory, 2022, GLA.

2. Current picture
Energy consumption - transport

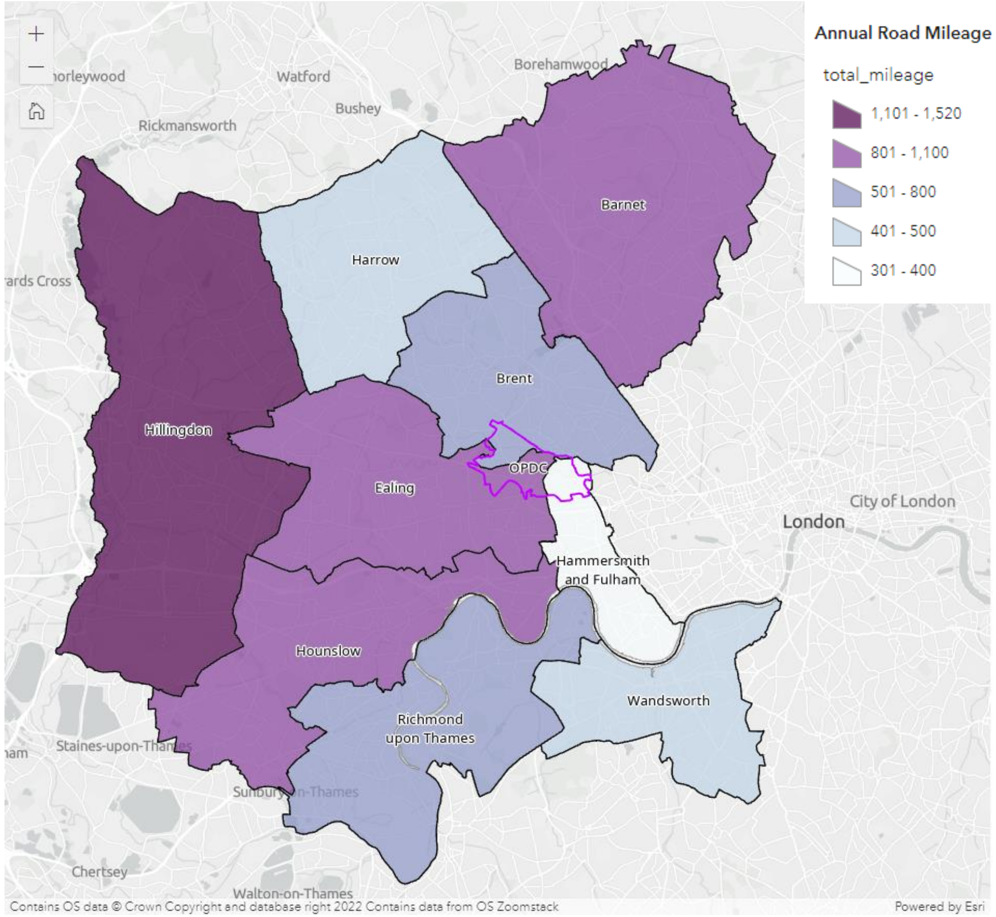


Figure 2.10: Annual road mileage across the nine West London boroughs in millions of vehicle miles. Source: Road traffic statistics (TRA), 2022, DfT.

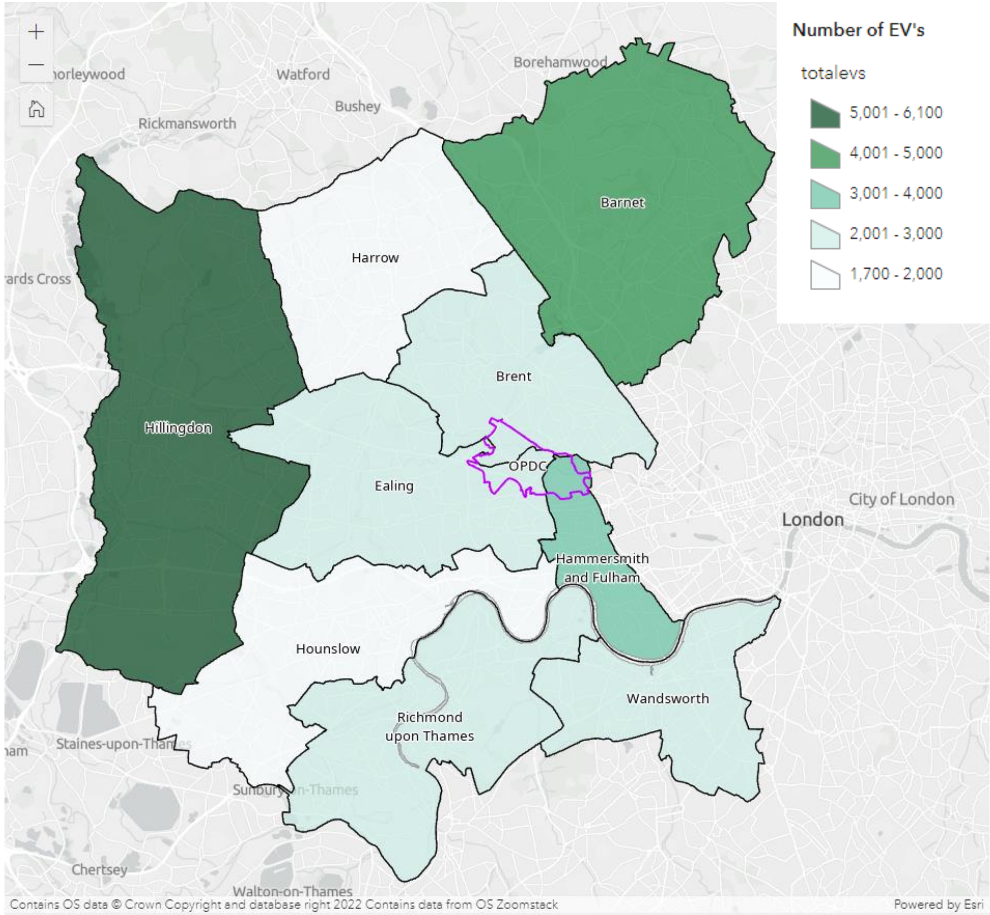


Figure 2.11: Total number of current electric vehicles in the nine West London boroughs. Source: Vehicle licensing statistics data tables, 2022, Department for Transport.

2. Current picture
Electricity distribution network

West London's electricity network is operated by two distribution network operators (DNOs); UK Power Networks (UKPN) and Scottish and Southern Electricity Networks (SSEN).

Data related to the locations of West London's primary substations and the areas that these serve has been provided by the DNOs. Data relating to the current capacity of substation was also provided.

Figure 2.12 shows substation demand headroom forecasts for this year (Winter 2023). This data was taken from UK Power Networks's and SSEN's network headroom report. Demand headroom represents the spare capacity available in the network to accommodate additional demand without reinforcement.

It is important to note that whilst some substations are shown to have capacity, new connections might not progress due to constraints on National Grid's transmission network. The impact of upstream constraints on the distribution network is set out the '[West London Electricity Capacity Constraints]() update – June 2023' report, commissioned by the GLA. This report illustrates the anticipated headroom constraints across West London as a result of increased distribution applications, with particular focus on SSEN's license area.

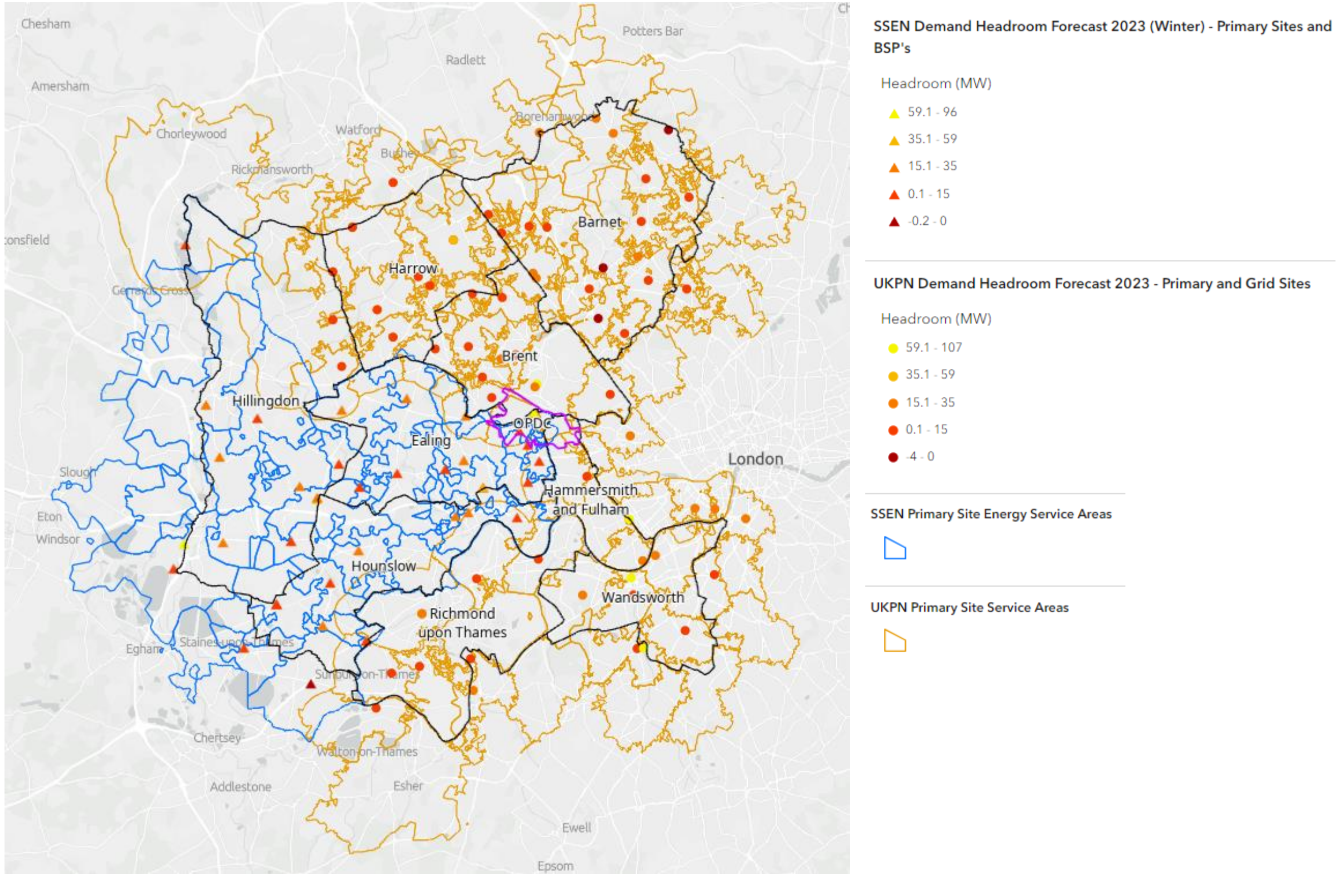


Figure 2.12: SSEN and UK Power Networks substation demand headroom forecast (Winter 2023). Source: SSEN Network Headroom Report (May 2022) and UK Power Networks Network Headroom Report (April 2022).

2. Current picture
Data centres

Data centres are buildings that house computing hardware, servers and storage systems. There is a high concentration of data centres in West London due to existing IT cable infrastructure that runs from America and Ireland into London through the area, as well as proximity to London, and its wealth of customers for data services.

Data has been provided by TechUK that shows the locations and sizes of data centres across West London. There are 22 existing data centres with a total of 273 MW of IT load distributed across Brent, Ealing, Hillingdon and Hounslow, with at least four of these data centres in OPDC.

Figure 2.13 and Table 2.2 show a summary of data centre numbers and IT load across West London. While it was not possible to obtain specific spatial and capacity data for all sites due to data sensitivity, the data collected shows a particularly high concentration of data centres in Hillingdon, primarily driven by four adjacent Virtus colocation data centres, which have a collective IT load of 86 MW – larger than the total data centre load of any other borough.

As very large individual electricity network customers, the way that these data centres connect to the electricity distribution and transmission network strongly determines the network capacity available for other development in the area.

Data centres' IT hardware generates significant amounts of heat (at around 20-30°C), which is typically expelled into the external environment through the building's cooling system. Data centres could offer a significant opportunity for localised heat decarbonisation solutions, where instead of being expelled, this waste heat could be captured and redistributed to nearby buildings through a district heating network. It should be noted that such systems require a heat pump to elevate the temperature of the waste heat to a level that is useful in buildings – this comes with an electricity grid connection requirement.

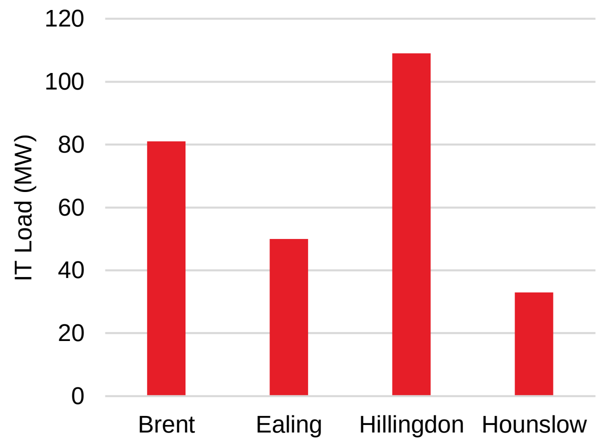


Figure 2.13 Existing IT load of data centres. Source: TechUK.

	Number of sites	IT Load MW	Estimated % of total electricity demand
Brent	2	81	39%
Ealing	6	50	25%
Hillingdon	8	109	42%
Hounslow	6	33	19%

Table 2.2: A summary of existing data centres in West London by borough. Source: TechUK.

2. Current picture
Summary

The energy system in West London today

West London is comprised mostly of residential, as well as significant commercial and industrial areas. Generally commercial and industrial buildings consume the most electricity, whilst residential buildings consume more heat. Overall, heat demand comprises a larger component of building energy demand relative to electricity demand. Around 95% of existing buildings are heated by natural gas.

For transport, 80% of driven miles are attributed to private cars, only a negligible proportion of these journeys are with Electric Vehicles (EVs).

West London's electricity network is operated by two DNOs: UK Power Networks and SSEN. Both license areas have capacity constraints, on specific substations, and there are constraints on the National Grid transmission network too.

In West London, data centres alone account for a substantial proportion electricity consumption, representing 18% of total demand. There are 22 known data centres with a total of 273 MW of IT load distributed across Brent, Ealing, Hillingdon and Hounslow. Four of these are in OPDC. Data centres' represent a significant opportunity for the decarbonisation of heat.

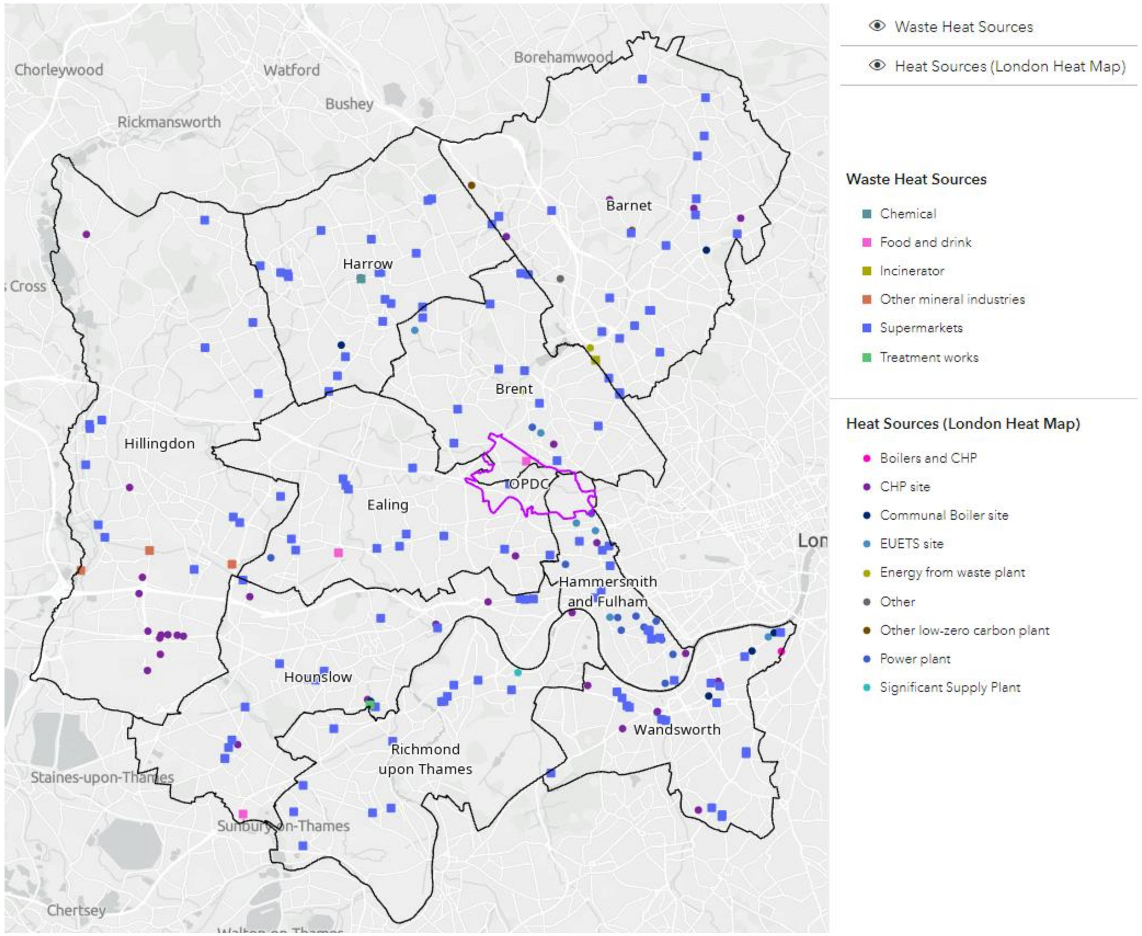


Figure 2.14 Existing West London waste heat sources. Source: London Heat Map and DESNZ. Note some data entries shown may be old or incorrect.

ARUP

Chapter 3: Future picture

3. Future picture
Context

Planned growth

Table 3.1 adjacent summarises the data collated and provided by each borough on planned residential and non-residential growth. The time horizon included for each borough varies slightly based on the extent of planning for residential growth for each borough.

The growth in each borough was provided over varying timelines, and extrapolated to 2050. Assumptions were made about the average floor space of a new home for each borough. This was combined with energy demand benchmarks to calculate the electricity, heating and cooling demands for each year to 2050.

These projections were used to estimate the resultant additional MVA power capacity connection requirements to the electricity distribution network.

Please note that the quality of data received, including the granularity of data, split between typology and the year to which projections were provided varied hugely. This is partly due to the variance in when each LPA last adopted a new Local Plan.

Local Planning Authority	Number new homes	New commercial floorspace (square m^2)	Completion year for new developments	Estimated resultant MVA at completion year (maximum)	Estimated resultant 2050 MVA (maximum)
Barnet	57,255	753,000	2036	732	1,490
Brent	28,110	No data	2042	310	363
Ealing	40,740	572,000	2034	588	1,500
Hammersmith and Fulham	20,184	626,000	2030	354	1,120
Harrow	9,427	No data	2030	108	330
Hillingdon	6,992	224,335	2026	69	357
Hounslow	23,982	741,000	2035	412	799
OPDC	22,630	871,239	2043	447	545.7
Richmond	1,300	No data	2030	22	58
Wandsworth	29,873	No data	2041	293	311.9

Table 3.1: Planned residential and commercial growth by borough. Source: Arup analysis based on development trajectories provided by boroughs.

3. Future picture
Context

Retrofit

Figure 3.1 shows the potential for energy demand reduction that could come from two modelled building retrofit scenarios: deep and shallow. In each scenario, different levels of retrofit intervention have been applied. In general, shallow interventions could be actioned with minimal disruption to the building use / operation. Deeper retrofit interventions are more costly and may require the building to be vacant in order to undertake the works. In all cases, values are modelled – actual achievable demand reduction will vary and is subject to detailed building surveys and designs. *Note: heat generation technologies like heat pumps are not included in retrofit scenarios.*

	Shallow retrofit	Deep retrofit
Measures	• Building automation and BMS • Building services interventions such as recommissioning of ventilation and cooling • Fabric improvements including glazing, air tightness and roof/loft insulation	• All shallow measures, extended to include non-domestic buildings • Wall and floor insulation – all appropriate buildings • Replacement of poor-performing double glazed windows – appropriate residential buildings
Impact	• **35% average reduction** to baseline heat demand • **21% average reduction** to baseline electricity demand	• **62% average reduction** to baseline heat demand • **22% average reduction** to baseline electricity demand

Table 3.2: A summary of the modelled retrofit scenarios

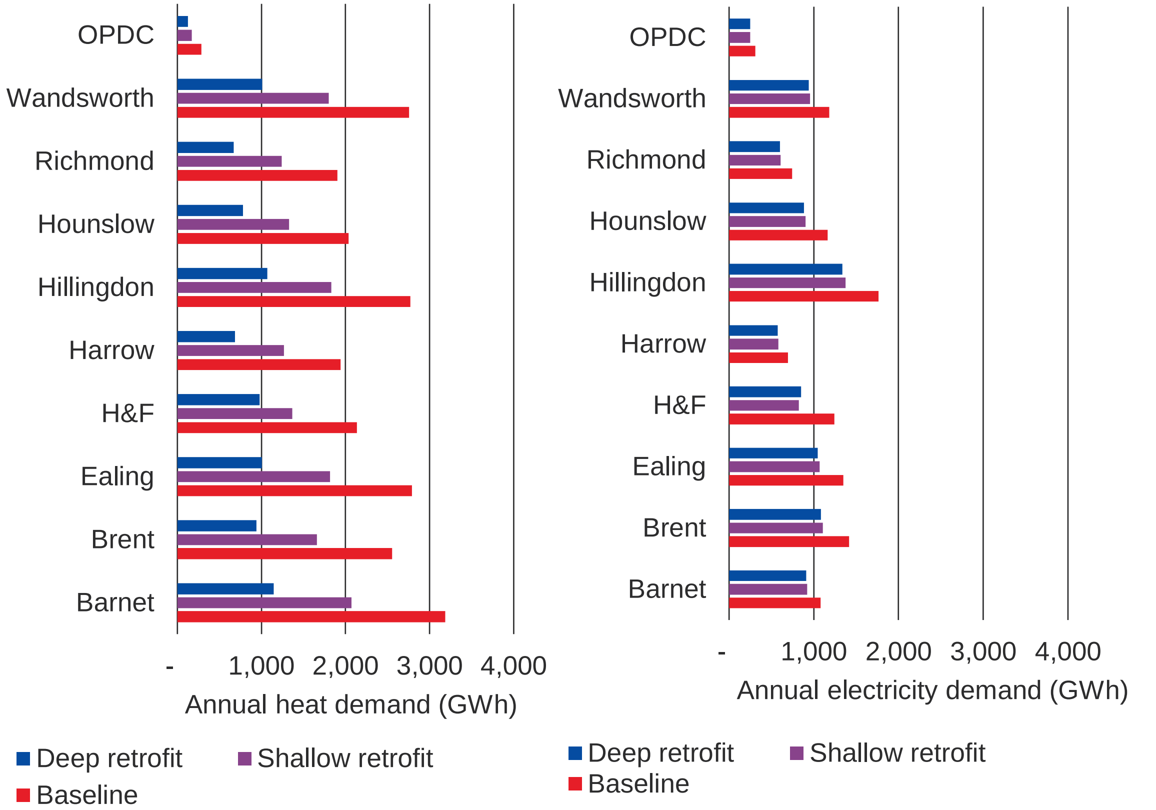


Figure 3.1: Energy demand reduction potential for heat (left) and electricity (right) across a shallow and deep energy efficiency retrofit scenario. Source: Arup & Skenario Labs analysis based on Ordnance Survey data.

** Please note that the changes in heat and electricity demand here do not account for the choice of heating technology, eg ASHP or GSHP. The demand for electricity corresponds lighting, appliances and sockets and does not include electricity consumed in creating heat.*

3. Future picture
Context

Data centres

Figure 3.2 shows the anticipated growth in data centre IT load from 2023 to 2026, in Hounslow, Hillingdon, Ealing and Brent. The data, provided by TechUK, includes the location and size of data centres within West London. From 2023 to 2026 onwards, the number of data centres in West London is projected to rise from 22 to 51, with the IT load (MW) expected to increase by over 1GW.

Hillingdon is expected to see the greatest increase in both the IT load and number of data centres. According to Table 3.3, there are 17 additional data centres scheduled to become operational between 2023 to 2026 onwards. These data centres contribute to an increase of 573 MW in IT load (which represents an even higher electricity connection capacity). Additionally, there is only one data centre planned to go live in Hounslow, from 2026 onwards. This particular data centre represents a significant IT load of 120 MW.

As mentioned in Section 2, spatial and capacity data could not be obtained for all sites due to data sensitivity.

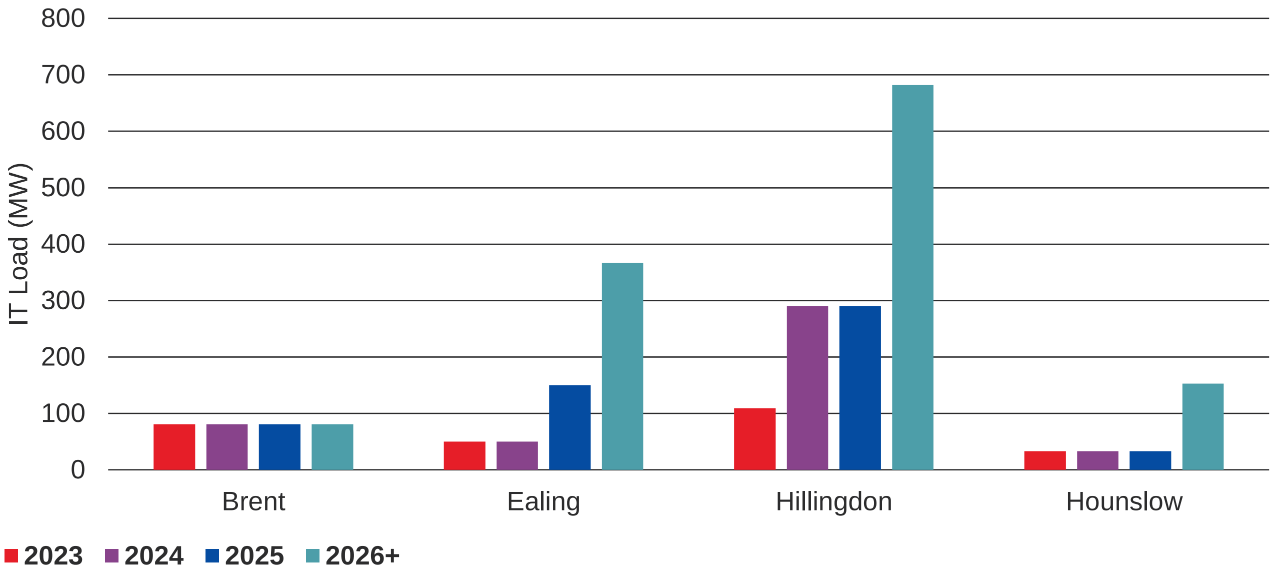


Figure 3.2: Planned data centre IT load from 2023 to 2026 onwards. Source: Tech UK.

Council	Number of site in 2023	Number of sites in 2026+	IT Load MW in 2023	IT Load MW in 2026+
Brent	2	4	81	81
Ealing	6	15	50	367
Hillingdon	8	25	109	682
Hounslow	6	7	33	153

Table 3.3: A summary of planned data centres in West London. Source: Tech UK.

3. Future picture
Context

Renewable power generation

Due to the urban nature of West London, rooftop PV is the primary feasible technology available for local renewable energy generation.

An estimate for the rooftop PV generation potential across the area, shown in Figure 3.3, was carried out based on data provided in the GLAs Solar Opportunity Map*, produced by the UCL Energy Institute. Generation potential was calculated by identifying viable roof space.

From this, it has been identified that there is potential for almost 3.5GWh of annual electricity generation if PV panels were to be installed across suitable rooftops in the area. In addition to rooftop PV potential identified, opportunities are also available to install additional capacity at locations such as reservoirs in the vicinity of Heathrow airport, building on an existing solar PV array

According to data from DESNZ, there is currently 62 MW of PV installed across the area, with an additional 35 MW currently in planning. Less than 3% of the total solar opportunity identified in the GLA opportunity map is currently utilised through existing or planned installations. Several factors contribute to the slow deployment of solar PV in London, including capacity constraints, high upfront costs, restricted rights to roofs, and limited awareness of incentive programs among homeowners.

It is important to note that solar PV will only alleviate constraints if generation is used or stored locally. If solar PV generated energy is exported back to the already constrained grid, it may lead to generation curtailment.

** Please note that due to LiDAR data gaps in the area covering the Heathrow flight paths, the GLA Solar Opportunities Map is incomplete. The total generation potential is therefore underestimated, leading to potential generation being displayed as 0 kWh (shown as a pale-yellow colour on the map) in the boroughs of Hillingdon, Hounslow, Harrow, and Ealing. .*

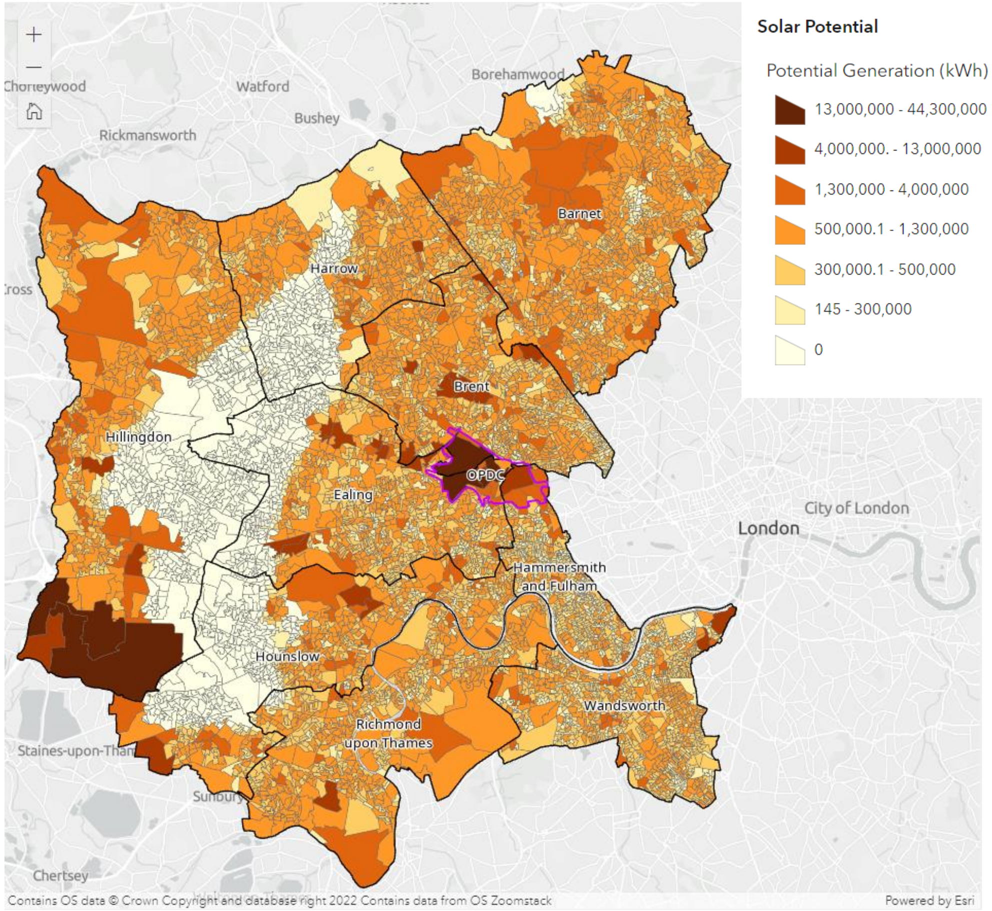


Figure 3.3: Annual rooftop PV generation potential (kWh) by OA. Source: GLA's Solar Opportunity Map.

3. Future picture
Accelerated green pathway

Overview

The Mayor of London has set a target for London to be net zero carbon by 2030. In 2022 the GLA published *Analysis of a Net Zero 2030 Target for Greater London,* which selected the 'Accelerated Green Pathway' – rapid and extensive electrification – as the preferred route to achieving this target. This scenario places strain on West London's local electricity infrastructure.

Findings were based on the Zero Carbon Pathways Tool, which breaks down energy and carbon emissions for each London borough, and for London as a whole. This includes trajectories for energy, the retrofit of homes and businesses, installation of heat pumps and district heat networks, and the decarbonisation of transport.

These trajectories illustrate the overarching vision for London and subsequent analysis performed by LAEPs is expected to draw on this vision while tailoring recommended interventions to the local context, picking up on more specific local opportunities and constraints. Subsequent LAEPs may justify deviation from this chosen pathway, where there are local opportunities or constraints that justify this to achieve the Net Zero target.

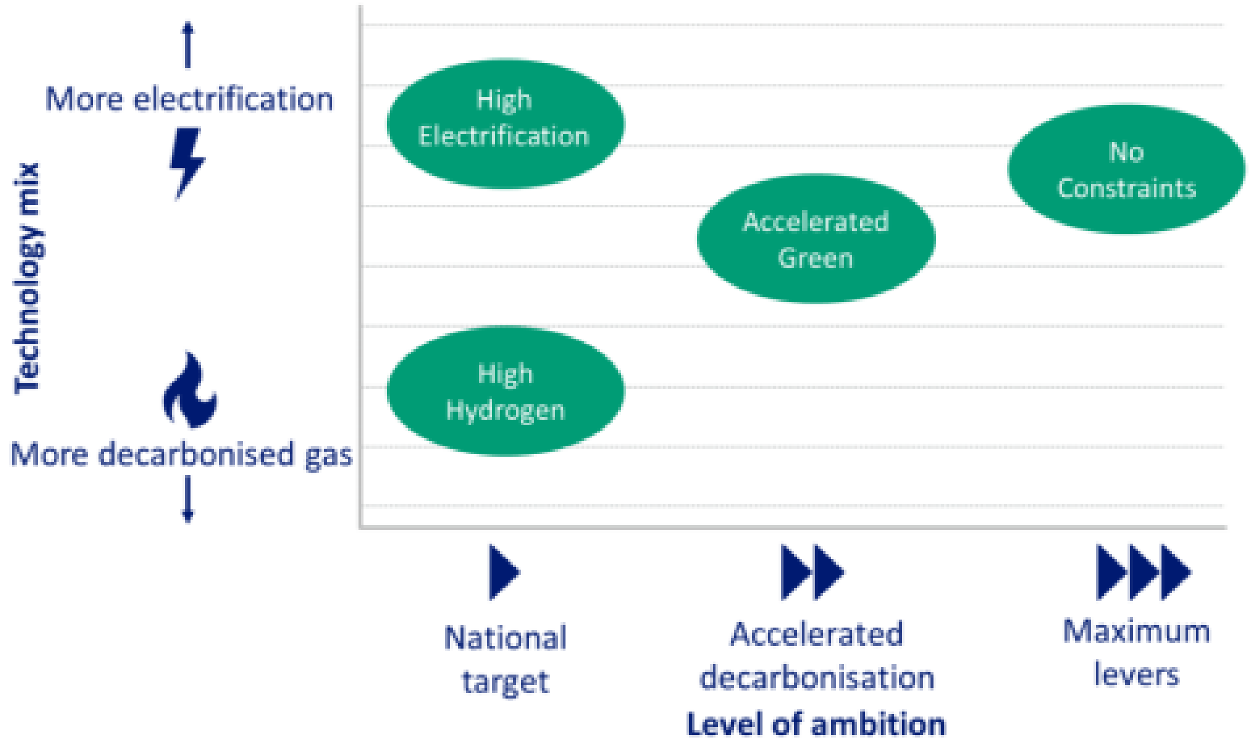


Figure 3.4. The Mayor of London's response to the Zero Carbon Pathways Tool, selecting the Accelerated Green pathway as the preferred option for London. Source: [1]Pathways to Net Zero Carbon, GLA, January 2022

3. Future picture
Hydrogen in West London

Overview

Cadent is the Gas Network Operator (GNO) in West London and was engaged as part of this study. They also provided gas consumption data by borough, split out by residential, commercial and industrial uses which can be visualised in the LEAR tool. Cadent has undertaken a study called Capital Hydrogen, which summarises their vision for the role of hydrogen in London. Although Cadent is confident that polyethylene (PE) gas mains are capable of distributing hydrogen gas, producing it and getting it into the city in the first place is much harder. Cadent target for gas mains conversion to PE is 89% by 2032.

Thereafter, it is expected that any hydrogen gas available in the city will be directed as a priority to larger industrial / commercial loads (e.g. heat networks), including industrial production processes, and transport demands, such as heavy goods vehicles, with residential dwelling level heating lower down the hierarchy.

Cadent plans are most progressed for supplying hydrogen into East London, with no credible plans for how it could be supplied to West London, and not in the timeframes required to meet Net Zero 2030 targets.

Boroughs should stay informed of hydrogen plans for West London going forward, recognising the role it could play in decarbonising industry, transport, and, later, heating.

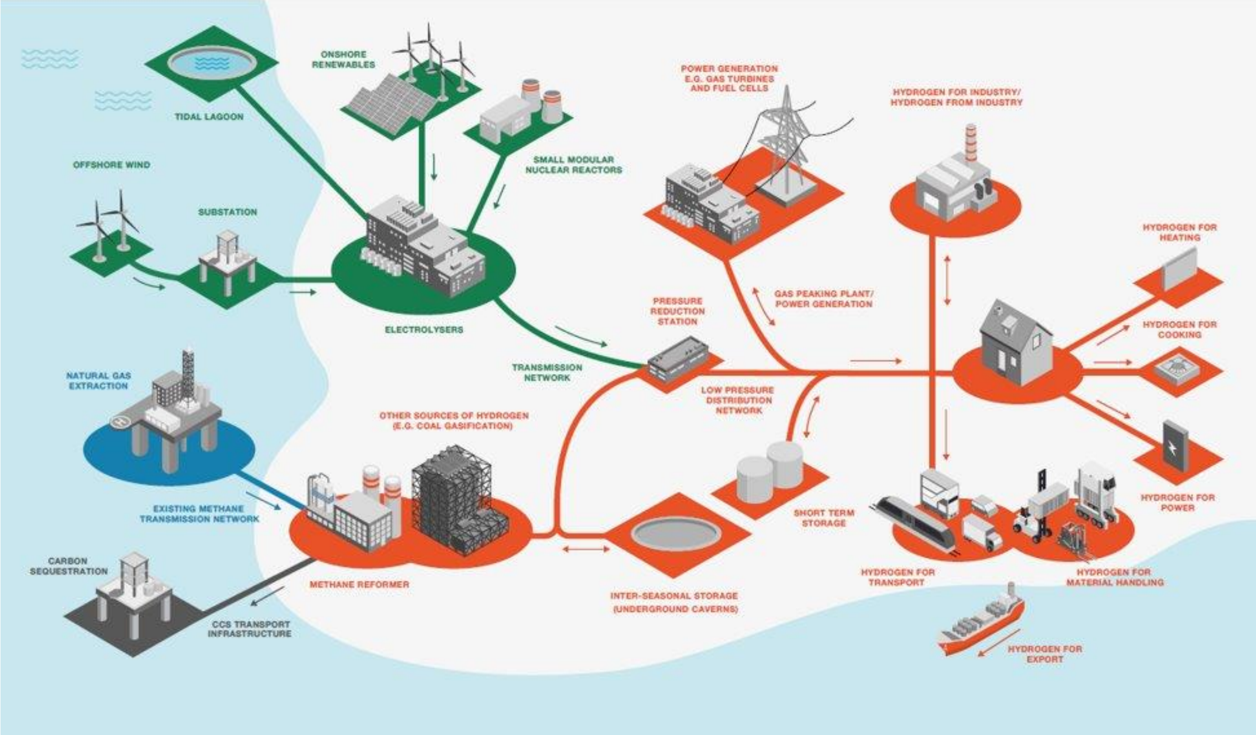


Figure 3.5: Arup visualisation of the future Hydrogen system/economy

3. Future picture
Heat networks in West London

Overview

Heat networks are in use and in planning across the sub-region. Those that exist already are largely fed by gas boilers and gas-fired CHPs and shall need to be decarbonised in line with Net Zero targets. Unless widespread hydrogen distribution is realised, it is expected that the methodology for decarbonisation will largely be by reducing operating temperatures and heat pump deployment.

Figure 3.6 shows the planned heat networks in the sub-region, as depicted by the London Heat Map. There may be other networks undergoing development that are not shown here.

The UK Department of Net Zero and Energy Security expect heat networks to serve around 20% of the UK's heating demand by 2050, up from today's rate of around 2%. This target is even higher in London where heat demand density is higher.

In order to meet targets, DESNZ are proposing to rollout Heat Network Zoning policy that will designate areas where connection to a heat network will be mandated. This will take a lot of the commercial risk away from operators and would likely speed up the deployment of heat networks significantly. The policy framework is currently in its pilot phase – for example OPDC is participating as a pilot area.

Using the building level heat demand data and a set of assumptions based around a linear heat density methodology, indicative heat network zones have been shown for the sub-region overleaf.

Both future demand scenarios are shown: the deep and shallow retrofit cases. As heat demand is reduced through deeper retrofit, so too is the size of the indicative heat network zones.

Whilst DESNZ is yet to publish how it intends to designate zones, it is likely there would be a nationwide modelling methodology employed, with a resource burden on Local Authorities to undertake the methodology, set zones and procure heat network partners to deploy networks within them.

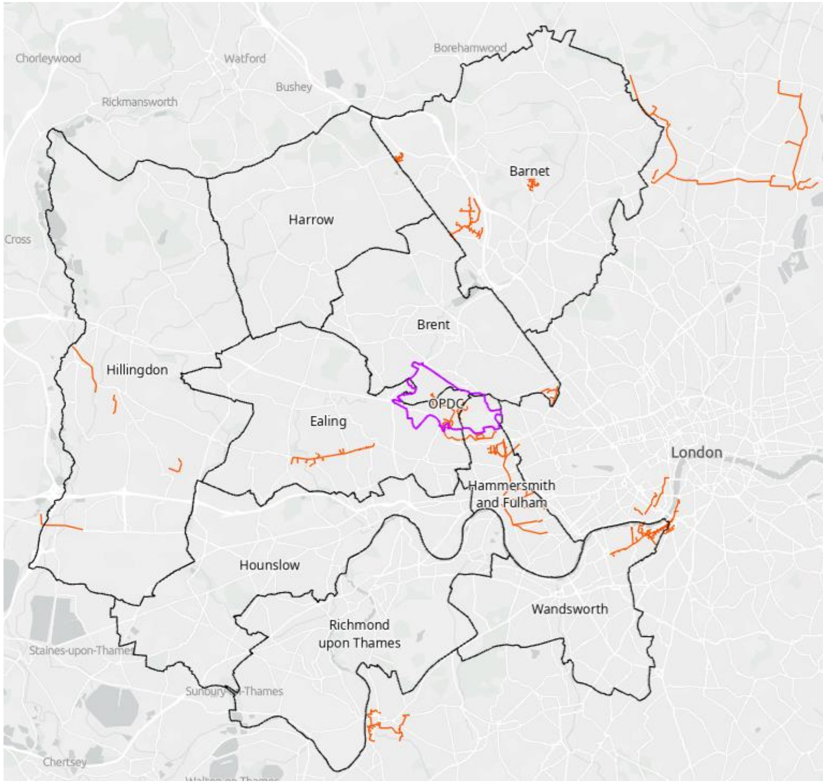


Figure 3.6: Planned heat networks in West London. Source: London Heat Map, Greater London Authority

3. Future picture
Heat networks in West London

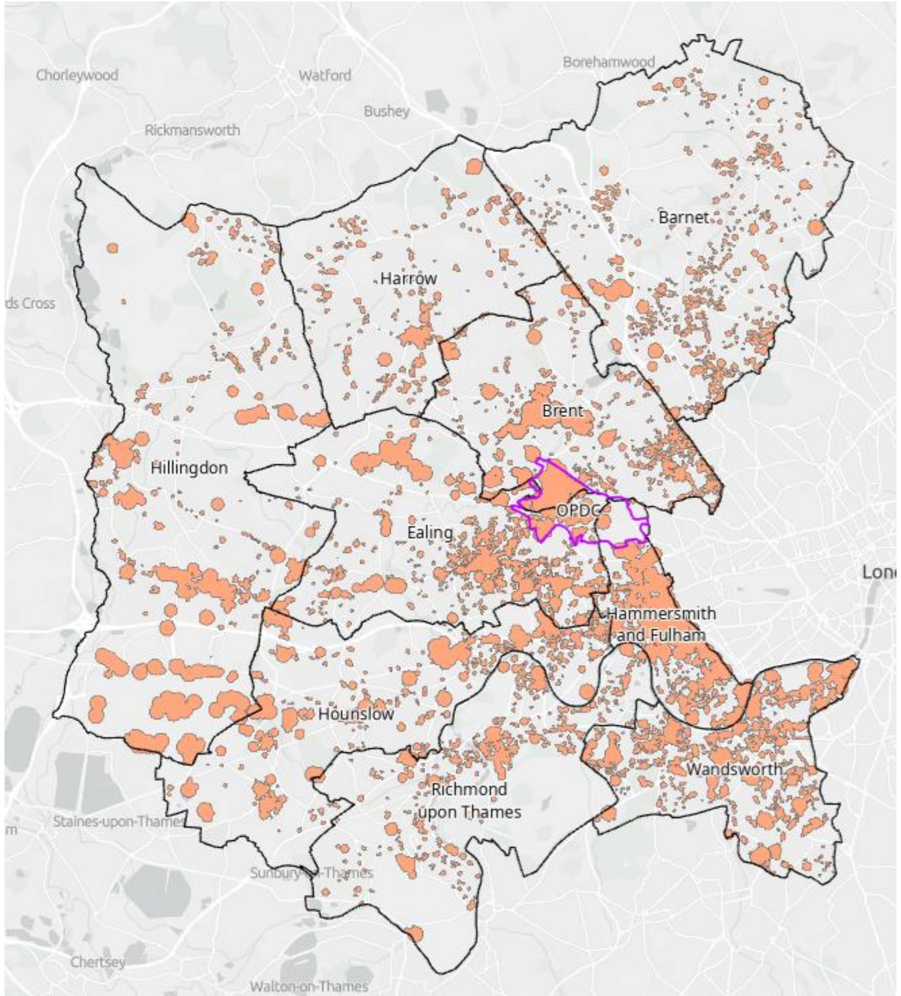


Figure 3.7: Heat network zones identified under the shallow retrofit scenario

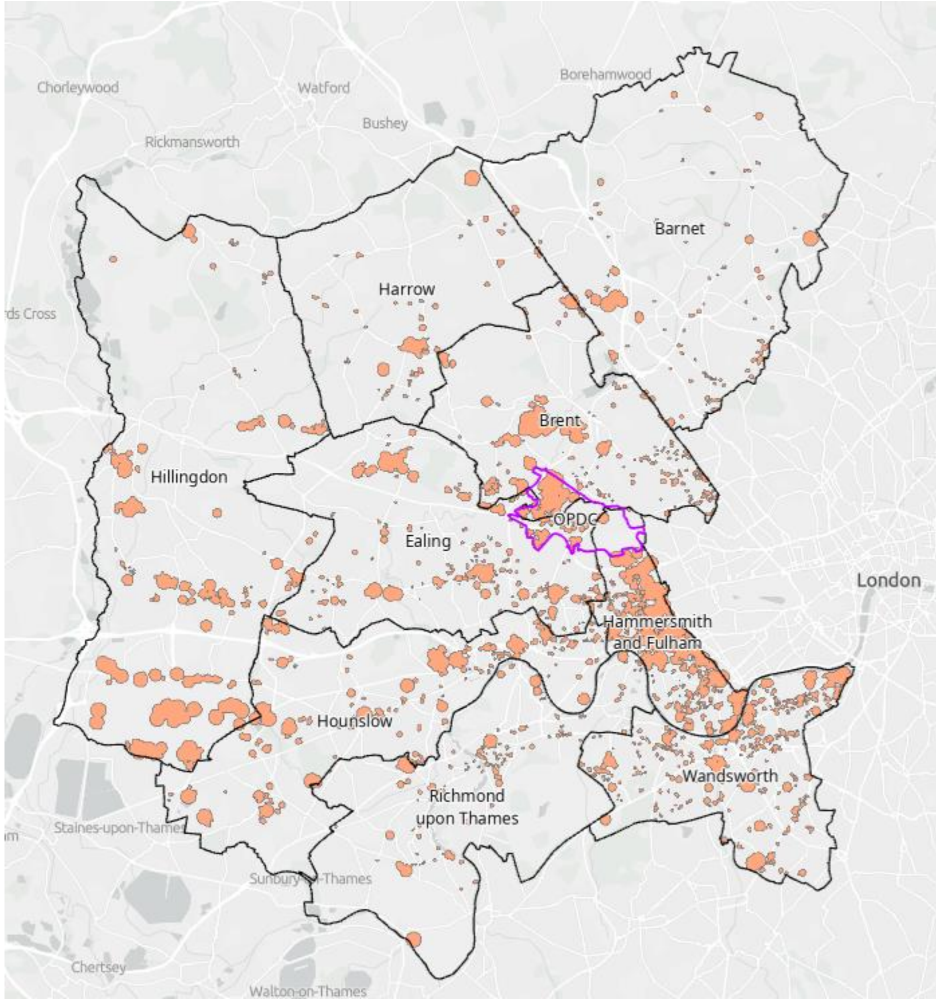


Figure 3.8: Heat network zones identified under the deep retrofit scenario.

3. Future picture
Accelerated green pathway

Projected Increased Demand

Figure 3.9 shows the expected increase in electricity demand (in MVA) across the West London sub-region, and compares it against the current (2023) available spare electrical capacity on the grid (headroom).

Key demands shown include: retrofit of existing buildings (including the impact of reduced heat demand and installation of heat pumps), electric vehicle chargepoint projections, new data centre connections and the construction of new residential and non-residential developments.

For new developments, a maximum and minimum scenario is given. The upper bound reflects a more conventional approach to electrical capacity sizing undertaken by developers/consultants, where connections are typically oversized. The lower bound (minimum scenario) represents the scale of the opportunity for new developments to reduce their peak power needs, through more efficient design and use of on site generation, storage and flexibility.

Borough level demand projections are provided in Appendix A.

Note: not all substation headroom shown can be assigned to West London, as some substations serve other areas outside the study boundary.

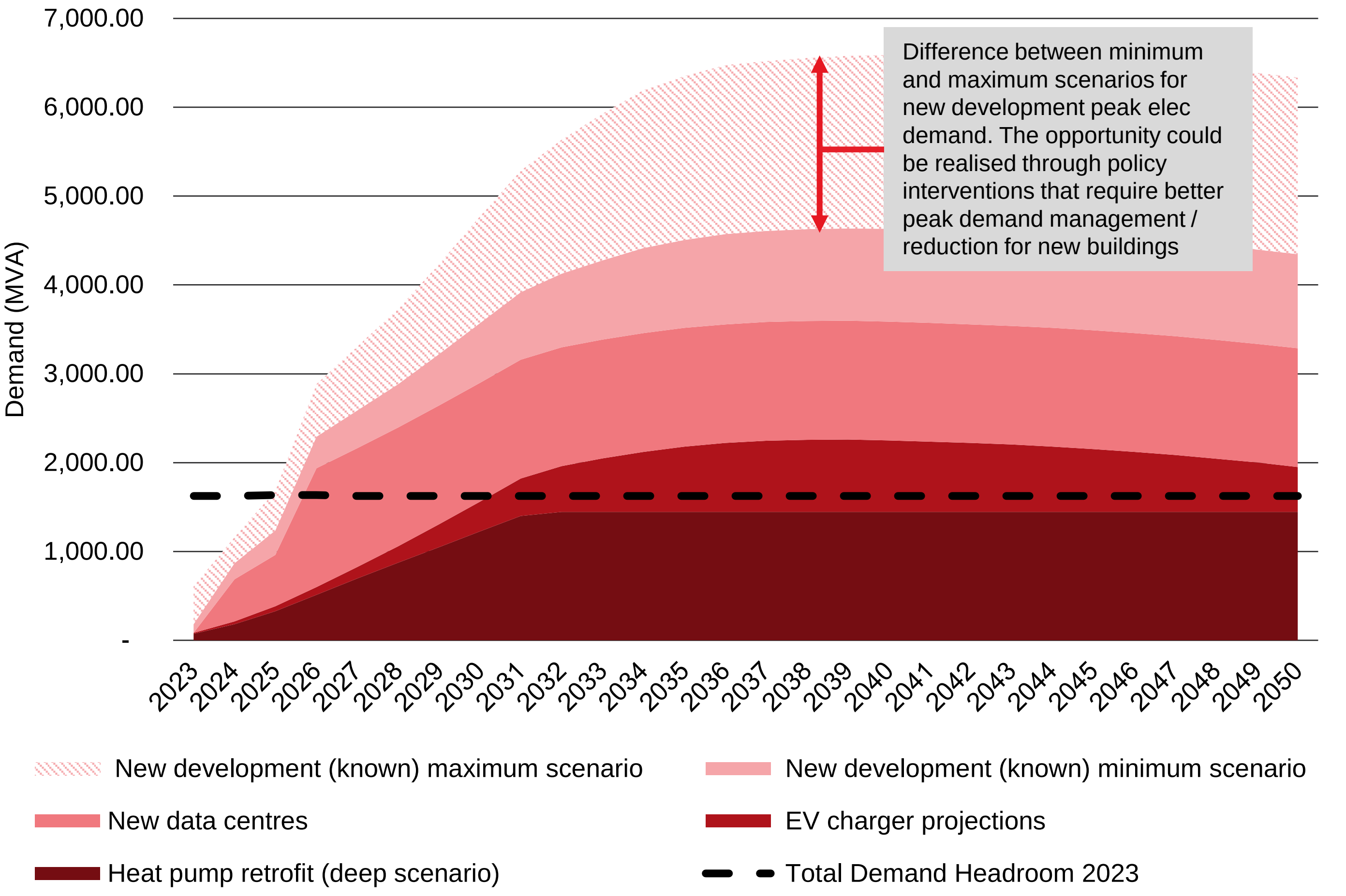


Figure 3.9: Projected electricity demand in West London compared to the total primary substation headroom available in 2023.

3. Future picture
Summary

The energy system in West London tomorrow

Over 200,000 homes and 3.5m m^2 of new commercial floor space are projected in the sub-region. Which represents significant new demand for power (see overleaf).

For existing building stock, two modelled building retrofit scenarios were undertaken: deep and shallow. In each scenario, different levels of retrofit intervention have been applied. In general, shallow interventions could be actioned with minimal disruption to the building use / operation. Deeper retrofit interventions are more costly and may require the building to be vacant in order to undertake the works and in residential applications, may save up to 65% of the heat demand.

Under the Mayor's Accelerated Green Scenario, which targets rapid electrification of heat and transport, the power demands of the West London sub-region are expected to grow by at least 4,000MVA. With lower levels of building retrofit or less efficient new development, this could be much higher.

The analysis has shown the future demand for power attributed to the needs of new development, electric vehicles, existing buildings and new data centres. Two scenarios for the demands of new development are shown, indicating the size of the opportunity to reduce the power needs of new buildings through policy interventions.

The graph compares the stacked demands against the 2023 available spare capacity (headroom), indicating the scale of reinforcement is upwards of 2,300MVA.

As future borough specific LAEPs are completed (i.e. stages 5-7 of the ESC methodology), it will important that they work with DNOs to help identify the quantity, location and timescales associated with low carbon technologies that rely on the electricity system, e.g. heat pumps, electric vehicle chargers and industrial electrification.

Chapter 4: Next steps

4. Next steps
Sub-regional and borough specific recommendations

Recommendations overview

The data and analysis presented on the previous pages demonstrates the scale of the change which is necessary to achieve West London's net zero carbon targets while supporting continued growth and a resilient energy system. The changes required can be represented by a set of priority intervention areas, which span across all areas and many technical interdependencies.

High level actions have been identified for each of the priority intervention areas, which are as follows:

- Electricity network reinforcement
- Energy system flexibility
- Decarbonise heat
- Energy efficiency upgrades in buildings
- Maximise local renewable generation
- Decarbonise transport
- Decarbonise major energy users

In the coming pages we discuss some of the next steps, using the colour coding shown in Figure 4.1 as to whether actions would be contained in borough specific LAEPs, or could be covered sub-regionally.

For sub-regional recommendations, responsibility for the delivery of actions across these intervention areas will vary, but key roles will be played by the GLA, National Grid, UK Power Networks, SSEN, Cadent and will also require collaboration with individual boroughs, business leaders and residents.

Similarly, while borough-specific recommendations seek to address more locally-owned aspects of the energy system, close engagement and collaboration with the previously mentioned stakeholders will be critical in successfully delivering integrated energy system change.

The borough-specific recommendations should be seen as an indication of where analysis and detailed recommendations in a full Local Area Energy Plan (Phase 2) should be focused. This is already underway for OPDC.

Further borough specific context on next steps can be found in Appendix B.

This study is the first subregional LAEP in London, and the findings and conclusions will serve as a basis for further subregional LAEP. work the GLA intend to carry out.

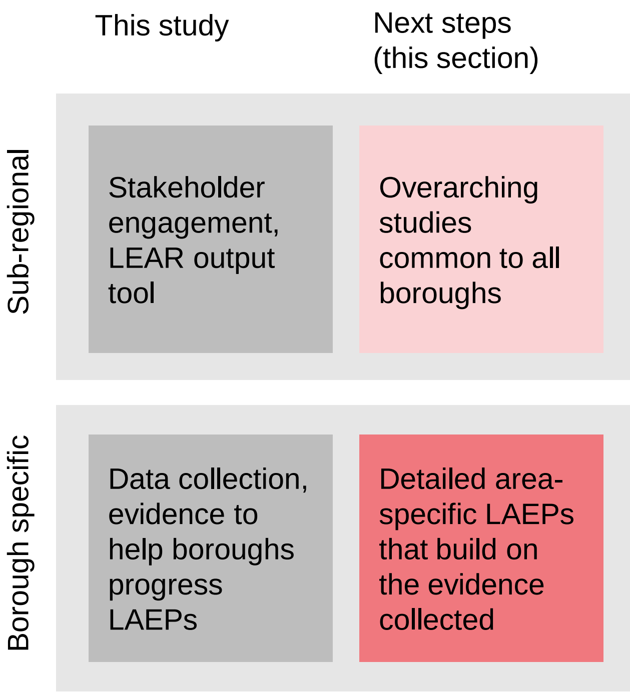


Figure 4.1: Summary of next steps provided

4. Next steps
Sub-regional and borough specific recommendations

Key
- Cross-cutting, sub-regional actions
- Borough specific LAEP actions

Electricity network reinforcement

As illustrated by the analysis in Chapter 3, peak electrical demands will quickly exceed current and planned substation headroom in West London, and in some cases will trigger significant upgrades to the transmission network, which comes with significant delay. This is especially acute in Hounslow, Hillingdon and Ealing.

Network upgrades are a priority intervention to allow new developments and local renewable assets to connect to the electricity grid, as well as meeting the increased electricity demand as a result of a shift to electrified transport and heat demand.

The GLA has been engaging closely with UK Power Networks, SSEN, NGET (National Grid Electricity Transmission) and NGESO (National Grid Electricity System Operator) to understand the extent of anticipated capacity constraints across West London, particularly within SSEN's license area. This work to date and the actions already taken to address the constraints are summarised in the 'West London Electricity Capacity Constraints update – June 2023' report.

This includes introduction of measures that allow 1MVA and 1MVA/year ramping developments to proceed, which have already allowed a number of housing developments to progress which would otherwise have been stalled.

Many larger developments are still stalled by transmission network upgrades due to be completed in 2037, some of which are driven by contractual capacity limitations rather than physical ones. NGESO has implemented a 5-Point Plan to try to address this discrepancy, which together with the Energy Networks Association (ENA)'s queue management reform work and SSEN's connection queue audit could help free up capacity in West London before 2037. The GLA can continue to support developers on a case-by-case basis in the interim, including where appropriate, to coordinate connections where developers choose to contract with adjacent Network Operators and encouraging developers to engage in conversations around shared street works to limit disruption.

West London energy planning next steps

Task	Description
Detailed network capacity assessment	Engage with and get the most up to date information from DNOs and TNO
LV infrastructure consideration	Work with DNOs to understand how low voltage (LV) network constraints could be better understood
Future demand assessment	Validate the expected electricity connection requirements for new developments and electric vehicle charging
Industrial demand assessment	Quantify the electrification needs for industry in the area
Heat pump power demand assessment	Quantify the power needs for rollout of heat pumps in homes
Large fleet electrification assessment	Identify major transport fleets in the area, and their power needs
Other electricity demand assessment	Identify any other needs for power, and sum the totals

4. Next steps
Sub-regional and borough specific recommendations

Key	
(light pink)	Cross-cutting, sub-regional actions
(dark pink)	Borough specific LAEP actions

Energy system flexibility

In addition to distribution and transmission system upgrades, West London Network Operators and NGESO propose use of flexibility solutions to help alleviate capacity constraints in the medium term (over the next 5-10 years), as outlined in the 'West London Electricity Capacity Constraints update – June 2023' report.

Smart grids and flexibility technologies such as energy storage and smart EV charging can be used to delay or in some cases potentially reduce the need for grid infrastructure upgrades, whilst also creating resilience in the energy system and reducing energy prices. West London stakeholders should support businesses and residents in the uptake of these technologies in pursuit of this.

Where possible, boroughs should look to embed flexibility considerations for new developments within their local plans. This would include ensuring new developments show how they are integrating thermal energy storage into power distribution and control systems in a way that reduces peak demand.

Boroughs may also explore additional levers to accelerate rollout of flexibility technologies in new developments, for example by carbon offset fund payment dispensation in cases where developments can demonstrate effective measures are being employed to reduce peak power requirements.

Boroughs should also encourage local businesses and stakeholders to participate in smart grids or flexibility pilots such as testing smart appliances and Time of Use Tariffs (TOUTs), which can serve as replicable models for implementing flexibility across London and the rest of the UK, and will help DNOs and planners understand the scale of the opportunity this offers.

Beyond this, boroughs will need to work with energy providers and DNOs to develop local flexibility pilots and trials among businesses and residents, to explore the use of smart tariffs and appliances to drive demand-side management.

Finally, thermal energy storage should be a key priority area in all energy efficiency retrofit works as a cheap, low maintenance, low embodied carbon means of maximising heat pump uptake and providing flexibility services in existing buildings.

West London energy planning next steps

Task	Description
Thermal storage study	Assess implications of putting thermal energy storage in existing buildings and homes, to maximise heat pump deployment and provide flexibility.
Public buildings flexibility	Undertake a study to show how public buildings can participate in flexibility markets, feed outcomes into LAEPs.
Flexibility uptake study	Engagement with DNOs and Ofgem to understand why flexibility uptake is low and what measures could be taken to improve it.
Flexibility policy and pilots	Rollout policy that promotes uptake of policy in London. Design a pilot studies to test interventions.
Whole systems modelling	Model the extent and scale to which vehicle to grid and smart charging, storage and demand side response can be utilised in the area:
Priority zoning for flexibility	Determine priority areas to target flexibility uptake based on network constraints, flexibility potential, and enabling factors (e.g., high proportion of existing residents on smart meters)
Thermal energy storage	Show how, and where in each borough, thermal energy storage could be installed / re-introduced as a key enabler for Net Zero.

Key

Key	
(light pink)	Cross-cutting, sub-regional actions
(dark pink)	Borough specific LAEP actions

4. Next steps
Sub-regional and borough specific recommendations

Decarbonise heat

Currently, most (95%) of the building stock in West London is heated by natural gas boilers. To transition towards a net zero energy system, these fossil fuel systems will need to be replaced with low carbon heating solutions. In West London, it is likely that heat pumps and heat networks will be primary heating alternatives used to decarbonise heating.

The accelerated green pathway sets an ambitious target of over 450,000 heat pump installations by 2030. In West London, 0.15% of buildings have a heat pump installed, meaning that to achieve the deployment targeted by the accelerated green pathway, an average of 50,000 heat pumps must be installed per year from 2023 to 2030. Since the average Energy Performance Certificate (EPC) rating across the subregion is D, the rollout of heat pumps should be accompanied by the installation of other energy retrofit interventions like fabric improvements. Roll-out should be targeted in areas with higher electricity demand headroom to limit additional near-term need for infrastructure reinforcements and additional costs being incurred by the consumers.

Further investigation could focus on identifying the technical, social and economic factors contributing to the speed of uptake across West London as a first step towards improving heat pump uptake.

Heat networks could also have a significant role in areas where heating demand is high, densely concentrated and within proximity to a centralised, low carbon heat source. The analysis conducted as part of this study identifies potential investable heat network areas in many areas in West London, which is also the subject of many other concurrent studies and work being undertaken by DESNZ on heat network zoning policy implementation.

Further analysis should focus in more detail on the feasibility of the identified zones, the cost effectiveness of implementing these heat networks, and the likely impact on residents' energy bills. Additional analysis could also be conducted to explore in more detail the potential for waste heat recovery from the sources identified through the LEAR, and into expanding existing networks into West London.

Where areas have a high number of residential heat demand co-located alongside commercial buildings with high cooling demand and other potential low-grade heat sources, the feasibility of thermal energy sharing via 5th generation ambient temperature heat networks should be explored.

West London energy planning next steps

Task	Description
Heat pump uptake study	Investigate which incentives and mechanisms could be used to promote heat pump uptake in the able to pay sector.
Supply chain study	Investigate whether the supply chain exists in West London to support the levels of heat pump rollout inferred by the Accelerated Green pathway.
Heat network zoning	Boroughs should work with DESNZ to designate heat network zones within their areas.
Heat network feasibility work	Carry out further analysis on identified heat network zones, determining the feasibility of delivering heat networks in these areas.
Develop heat pump priority zones	Determine priority areas for heat pump rollout, based on current EPCs, network constraints and the able-to-pay sector.
Heat pump rollout	Understand the rate and locations of heat pump deployment alongside network upgrades and energy efficiency interventions
Council stock heat decarb.	Develop a high level programme of works to decarbonise heat in borough's own stock

4. Next steps
Sub-regional and borough specific recommendations

Key
- Cross-cutting, sub-regional actions
- Borough specific LAEP actions

Energy efficiency upgrades in buildings

Enhancing energy efficiency in buildings plays a vital role in diminishing the necessity for network reinforcements, thus enabling the adoption of highly efficient low temperature heating systems such as heat pumps. Decreasing energy consumption will also lead to lower energy bills for residents, hopefully relieving pressure on households facing escalating costs.

Increased energy efficiency in buildings is mandated by the recently updated MEES Regulations, stipulating that many commercial properties with an EPC rating below E will be deemed “substandard”, with the minimum EPC rating changing to C in 2027 and B in 2030. As a result, landlords owning substandard properties face being prohibited from extending leases and tenants are at risk of increased rents.

A programme of works should be undertaken to retrofit each borough’s own building stock, social housing, and other non-domestic buildings such as schools. Community engagement, government incentives, planning measures and GLA support can be used to encourage and support homeowners, including landlords, in carrying out energy efficiency upgrades. This includes measures like external loft and underfloor insulation, smart metering, window sealing and double glazing. Properties with low EPC ratings in areas of high grid constraint should be prioritised, so that any efforts to reduce electricity demand in homes contributes to lowering the need for grid reinforcement.

As prescribed by the London Plan, new developments will be evaluated based on their compliance with energy efficiency requirements adhering to the “Be Lean” stage of the London Plan’s Energy Hierarchy, which emphasises the use of highly efficient building materials to minimise overheating, as well as incorporation of high efficiency lighting, ventilation and appliances.

West London energy planning next steps

Task	Description
Study on home fabric upgrades	Carry out a study into the mechanisms and incentives that could be used to promote fabric upgrade uptake in the able to pay sector
Expand the Retrofit Accelerator programme	Increase the level of funding available, and extend the timelines for the Retrofit Accelerator programme.
Embodied carbon study	Quantify the levels of embodied carbon associated with retrofit of existing buildings, and new development
Monitor Minimum Energy Efficiency Standards compliance	MEES has changes as of April 2023 – compliance will be monitored and enforced by Local Authorities.
Survey homes	Sense check the two retrofit scenarios detailed herein against a sample of council homes.
Determine retrofit profile	Develop a high level programme of works to rollout different levels of interventions in buildings, as determined via survey samples
Whole life carbon assessment	Calculate carbon savings from proposed energy system changes, compare to embodied carbon

Key	
(light pink)	Cross-cutting, sub-regional actions
(dark pink)	Borough specific LAEP actions

4. Next steps
Sub-regional and borough specific recommendations

Maximise local renewable electricity generation

West London's urban landscape is well suited to rooftop solar PV generation. The LEAR illustrates the potential for this technology in West London, with a total amount of 3.4GW if deployed to its maximum potential, according to the London Solar Opportunity Map. With a target of 1.2 GW of electricity to be generated from rooftop solar PV across West London by 2030 (35% of the theoretical potential), the Accelerated Green Pathway encourages locally installed solar PV as a way of empowering businesses and households to act as prosumers. Electricity generation of this nature can contribute to system flexibility and help alleviate electricity demand capacity constraints, if combined with electricity storage such as batteries.

To increase rooftop PV deployment, boroughs should target roll-out across all council-owned properties, with a particular focus on schools and other larger suitable sites. Examples of live projects in West London include the 1.7MW rooftop solar PV site at Western International Market, operated by the London Borough of Hounslow, and the rooftop solar installation on Avanti Secondary School in Harrow. Such opportunities may present revenue streams for the public sector through the sale of excess power via PPAs. For privately-owned buildings, boroughs can sign-post and provide guidance on existing schemes and funding opportunities, such as the 'Smart Export Guarantee' which compensates homeowners for the electricity they export back to the grid.

Key to greater and more rapid deployment of solar PV will be through identification of areas where generation potential is most dense (e.g. areas with more industrial buildings), and rolling out area-wide schemes that share battery storage facilities, and sell power locally to businesses with higher power consumption via private buried cables. Data centres, hospitals and infrastructure assets like wastewater treatment works represent good opportunities for customers on such schemes. Grid capacity constraints do pose a risk to solar deployment at scale; behind-the-meter schemes will be more feasible.

Finally, there may be additional opportunities for local generation by making use of reservoir space in West London for floating solar PV or transport infrastructure like railway sidings. The GLA and local boroughs should engage with water and transport stakeholders to determine the extent of this opportunity.

West London energy planning next steps

Task	Description
Investigation of novel solar models	Investigate funding and delivery mechanisms for rooftop PV, building on the GLA Solar Uptake research to identify opportunities. Assess new models that could promote area-wide uptake of PV.
Investigate sleeving of EfW power	Understand whether low carbon power from EfW plants in the Bristol region, which incinerate West London waste, could be sold back to West London, via the existing power network.
Map generation and storage potential	Fill in gaps in the Solar Opportunity Map and explore further potential opportunities such as floating PV.
Model scenarios	Model different scenarios of PV roll-out, capturing supply-chain and workforce requirements and constraints
Programme works	Develop a high level programme of works to roll-out PV on the borough’s own stock
Prioritise where to engage	Identify spatial areas for engaging with residents and businesses to encourage the uptake of rooftop PV.

Key	
(light pink)	Cross-cutting, sub-regional actions
(dark pink)	Borough specific LAEP actions

4. Next steps
Sub-regional and borough specific recommendations

Decarbonise transport

Decarbonisation of transport in West London will be dominated by electrification, in broadly four classes of vehicles: private cars, public transport (i.e. buses), public fleets (e.g. waste vehicles), and private fleets. Solutions for each of these vehicle classes will vary, and reflect differing levels of control and influence on purchasing decisions.

The delivery of charging infrastructure for fleet vehicles is expected to be led by fleet managers/owners (both private and public), and for buses will be led by transport providers (i.e. TfL). Private vehicle charging is more complex, where Local Authority roles and public investment can vary. Private sector involvement is also expected, particularly from developers and chargepoint providers.

In West London, active and public travel uptake should be improved as a priority over facilitating electric private cars. Forecasted road mileage driven by electric vehicles (EVs) is expected to increase significantly, from 800 million km to 6,000 million km according to the Accelerated Green Scenario. To meet this growing demand, it is necessary to scale up the deployment of charge points across the subregion. According to the results from the LEAR, it is projected that by 2050, the number of chargers must be increased from 3,900 currently recorded in the National Chargepoint Registry to 47,000.

To achieve this, boroughs should identify areas to install publicly available, rapid charge points, such as loading bays, off- and on-street parking, as a priority over EV charging hubs which have a greater demand for power. In areas where there is high electricity network capacity and substantial demand, boroughs should assess the financial viability of installing EV charging hubs, capable of efficiently charging large numbers of EVs simultaneously.

Boroughs with a constrained network, namely Ealing, Hounslow, and Hillingdon, should strategically plan the distribution of EV chargepoints by assessing the installation locations and local network capacity.

When aiming to encourage adoption among the able-to-pay market, boroughs should actively promote awareness of existing funding, such as the Office for Zero Emission Vehicles (OZEV) grant, and schemes designed to reduce the upfront capital costs associated with EV adoption.

West London energy planning next steps

Task	Description
Study on EV adoption in West London	Carry out a study into the mechanisms and incentives that could be used to promote EV uptake, as well as the varying delivery models and borough roles
GLA land assessment	Carry out an assessment of publicly-owned land that is suitable to support the delivery of public charge points and charging hubs
EV uptake modelling	Model different scenarios of EV uptake, and the rate of EV charging infrastructure build out required to meet demand
Priority zoning for charging infrastructure	Based on uptake, identify priority areas for the rollout of charging infrastructure, including a spatial assessment of the total number of home, public off-street and destination chargers required
Private and public sector engagement to deliver destination charging	Engage with local private and public sector stakeholders (e.g., offices, supermarkets, and NHS sites) to drive delivery of destination chargepoints.

4. Next steps
Sub-regional and borough specific recommendations

Key
- Cross-cutting, sub-regional actions
- Borough specific LAEP actions

Decarbonise major energy users

Collaboration with major energy users, such as Heathrow, water companies, data centre operators, industrial sites, Kew Gardens and NHS facilities to identify opportunities for reducing operational energy consumption is a key priority, which may help alleviate pressure on the electricity system. Engagement with major energy users can be facilitated by working with BusinessLDN, London Chamber of Commerce & Industry, Park Royal Business Group, TechUK, West London Business and asset owners.

In West London, data centres alone account for a substantial proportion electricity consumption, representing 18% of total demand. These facilities also release a considerable and consistent amount of heat from their cooling systems, which is well suited to upgrade for use in district heating networks, supporting local heat decarbonisation. Exploring the potential for utilising this waste heat should be a key priority, as well as conditioning developers of new data centres to provide the means for heat offtake.

With a large number of facilities, certain areas of West London would be well suited becoming pilot zones for testing of innovative energy reduction or flexibility interventions and distribution of any waste heat captured.

The potential for energy reduction and waste heat utilization can be expanded through further engagement with industrial sites and NHS facilities. Industrial sites and healthcare facilities both have significant energy demands but pose additional challenges to reduce and decarbonize their energy provision. Through engagement with these sites, specific priorities for these buildings can be identified and opportunities for integration into the wider energy system (e.g. by acting as an anchor load for a district heating network) can be explored.

West London energy planning next steps

Task	Description
Data centre optimisation	Undertake a study to look at how the role of data centres can be optimised in West London. Investigate to what extent DC heat offtake can offset grid upgrades.
Engagement with data centre providers	Engage with local data centre operators to explore opportunities for reducing operational energy use, flexibility and waste heat capture
Waste heat analysis	Understand the scale of waste heat produced by major energy users in the area, and explore the potential for waste heat capture and distribution
Engage with major energy users	Engage with major energy users in the borough (e.g., NHS trusts, industry) to understand priorities and opportunities to support energy demand reduction and decarbonisation, as well as gather more up to date energy demand information for key sites within areas

Appendix A

Borough specific power system load projection curves

Demand Projections
Borough-level breakdown

This Appendix includes graphs showing a borough-level breakdown of the West London subregional demand projections outlined in page 25.

The following graphs show the expected increase in electricity demand (in MVA), comparing them against the current (2023) available spare electrical capacity on the grid (headroom).

Key demands shown include: retrofit of existing buildings (including the impact of reduced heat demand and installation of heat pumps), electric vehicle chargepoint projections, new data centre connections and the construction of new residential and non-residential developments.

For new developments, a maximum and minimum scenario is given. The upper bound reflects a more conventional approach to electrical capacity sizing undertaken by developers/consultants, where connections are typically oversized. The lower bound (minimum scenario) represents the scale of the opportunity for new developments to reduce their peak power needs, through more efficient design and use of on site generation, storage and flexibility.

Projections for new developments are based on the known planned growth data outlined in Table 3.1. In some cases – particularly for commercial development – the quantum is not known. As such, future power projections should be viewed as minimum estimates.

Furthermore, there will undoubtedly be further electrical connection requirements that are not captured in the assessment, for example the electrification of private vehicle fleets and process loads.

Comparing the minimum scenario's load projections (in an effort to eliminate the impact of new development load uncertainty from cross-borough comparison), Ealing, Hillingdon and Hounslow are the most constrained boroughs. In the maximum scenario, this remains the same except that Barnet displaces Hounslow as the third most constrained borough. Considering the significant uncertainty in Barnet's new development data and resultant load projections, constraints shown may have inaccuracies.

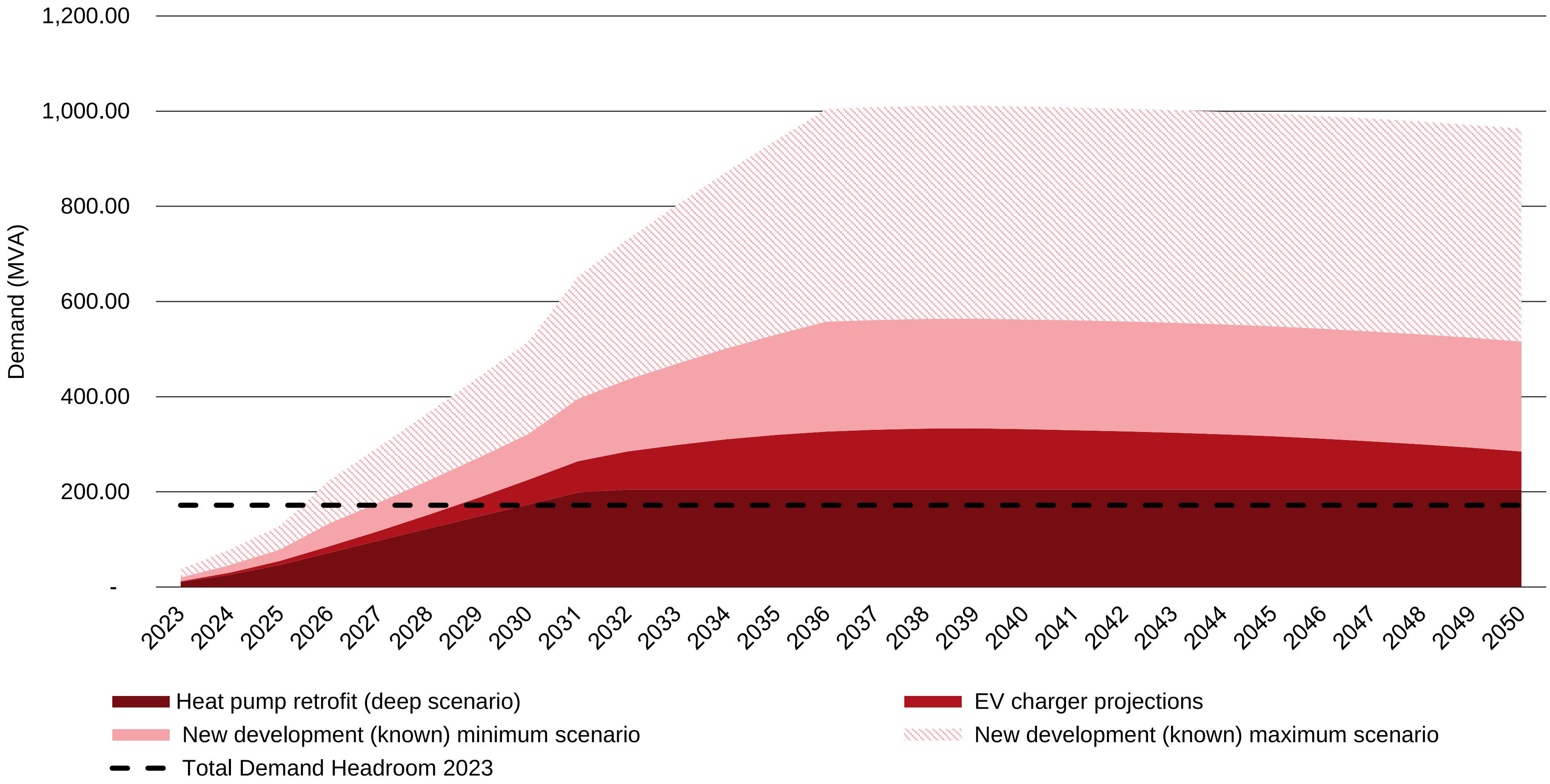
Ealing, Hillingdon and Hounslow's capacity constraints are predominantly caused by the significant loads of new data centre connections, with data centres contributing 32%, 71%, 22% of the total projected demand in 2050 in each borough respectively, based on TechUK data on planed new data centres for 2026 onwards. Hillingdon has the most significant data centre capacity of 710MVA.

Projected demand can be compared against the 2023 headroom figures for boroughs (black dotted lines). It must be noted, that as DNOs and National Grid invest in the infrastructure, this headroom will increase.

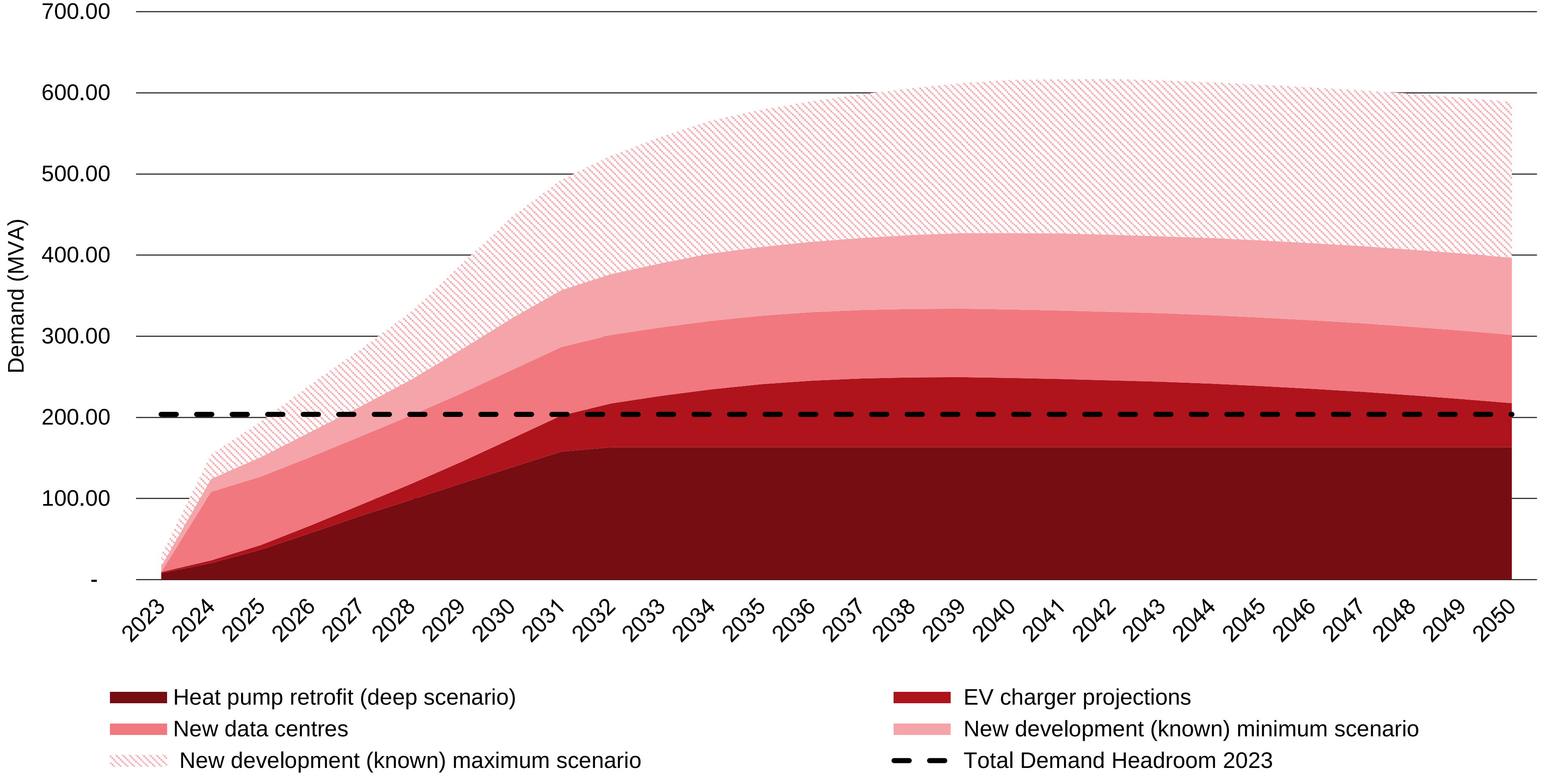
Electric vehicle chargepoints are assumed to be used consistently over time, and not displaced by hydrogen refuelling vehicles in the future.

Because headroom and projected demand is aggregated up to borough level, the analysis misses the individual constraints at a substation level. Please refer to the GLA's 'West London Electricity Capacity Constraints update – June 2023' document for further details on this issue.

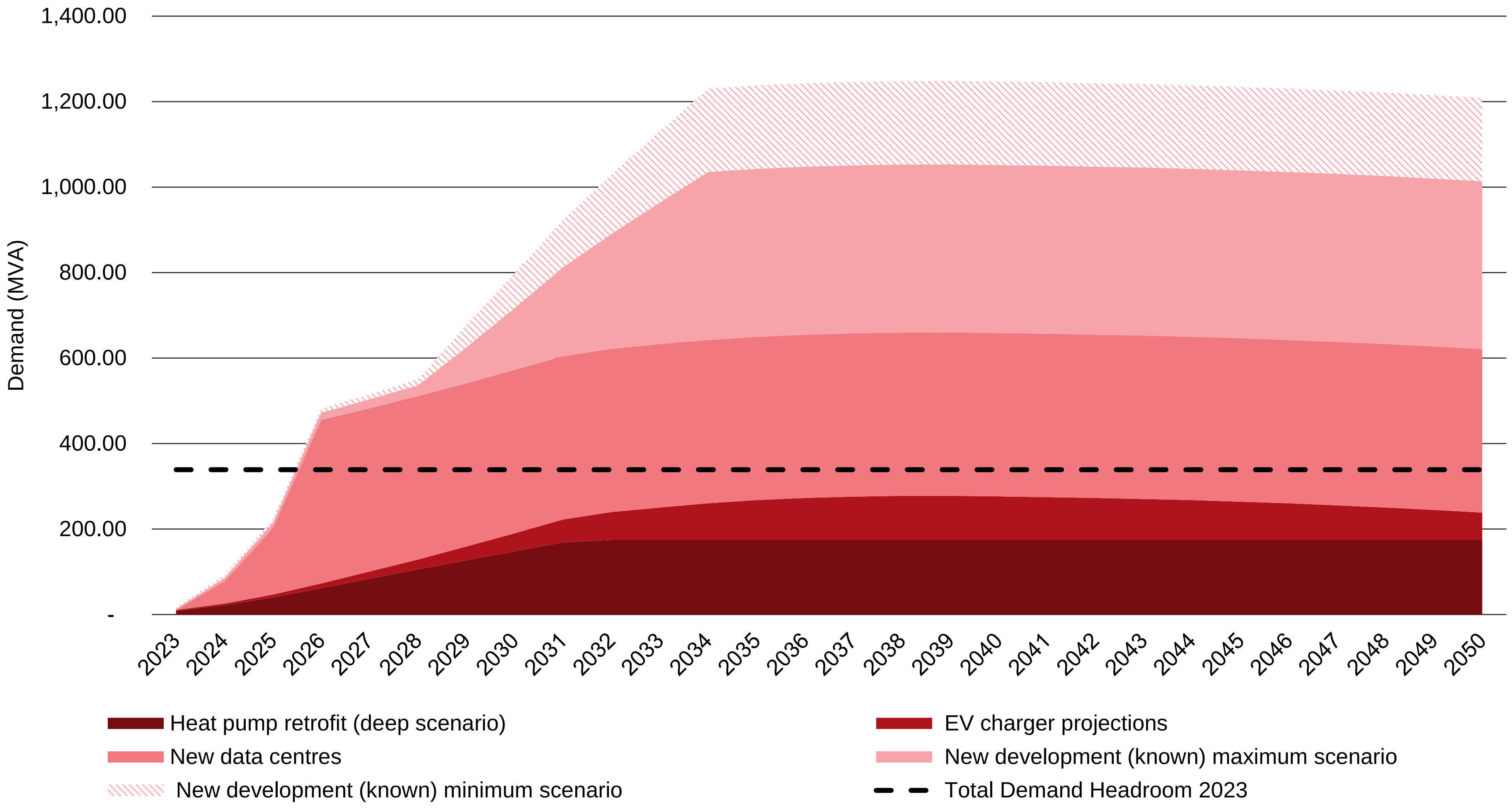
Demand Projections
Barnet



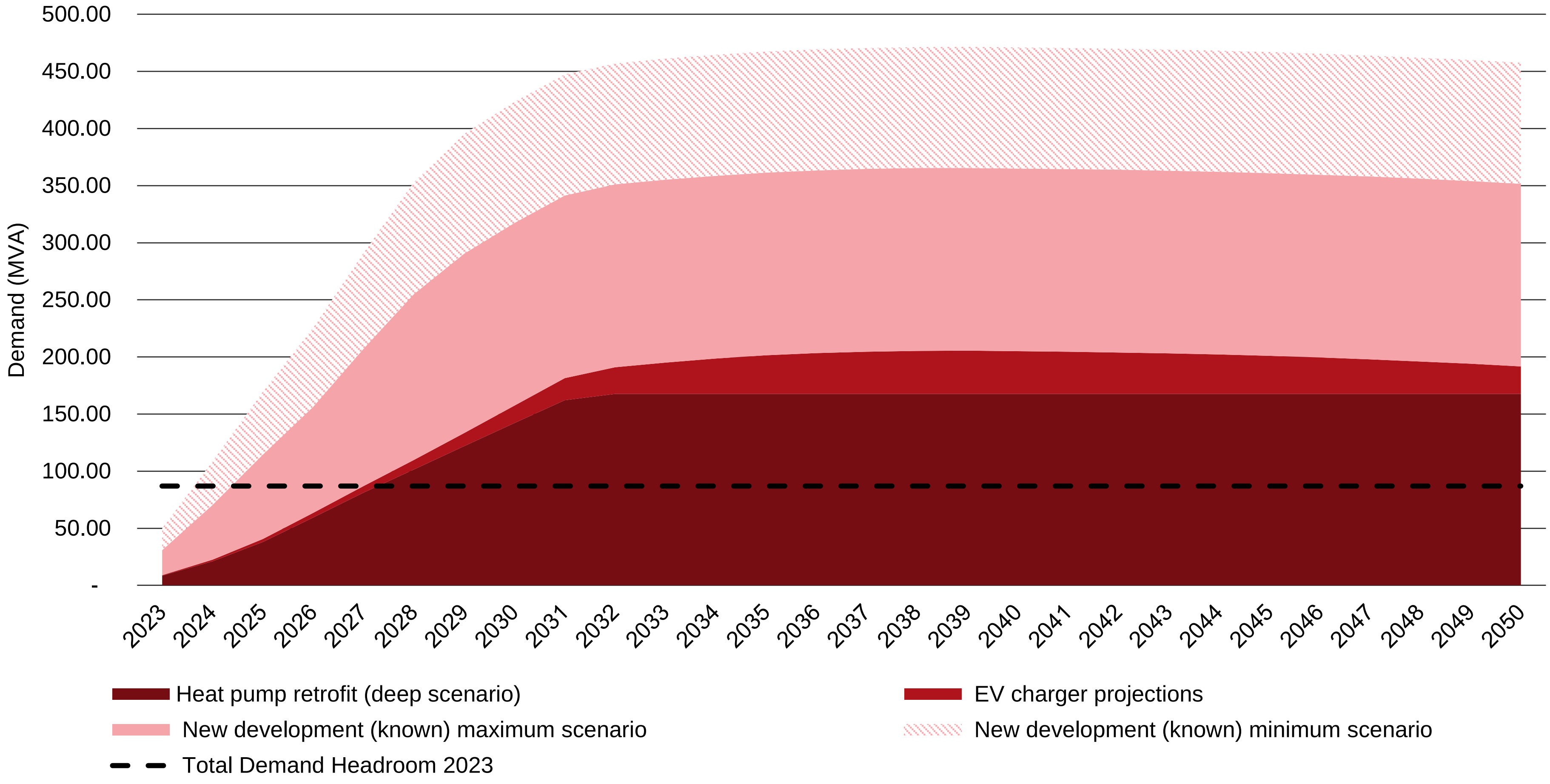
Demand Projections
Brent



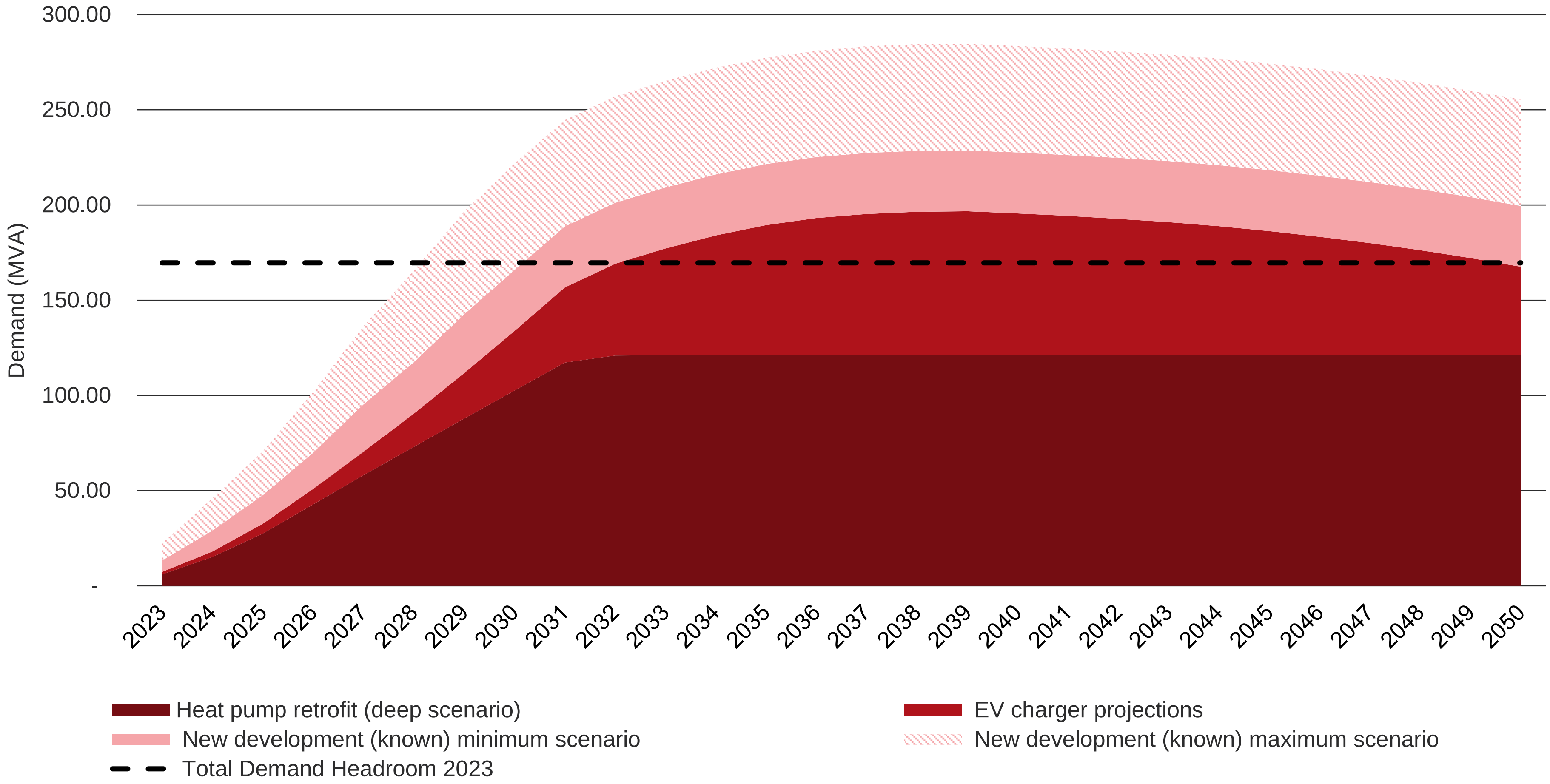
Demand Projections
Ealing



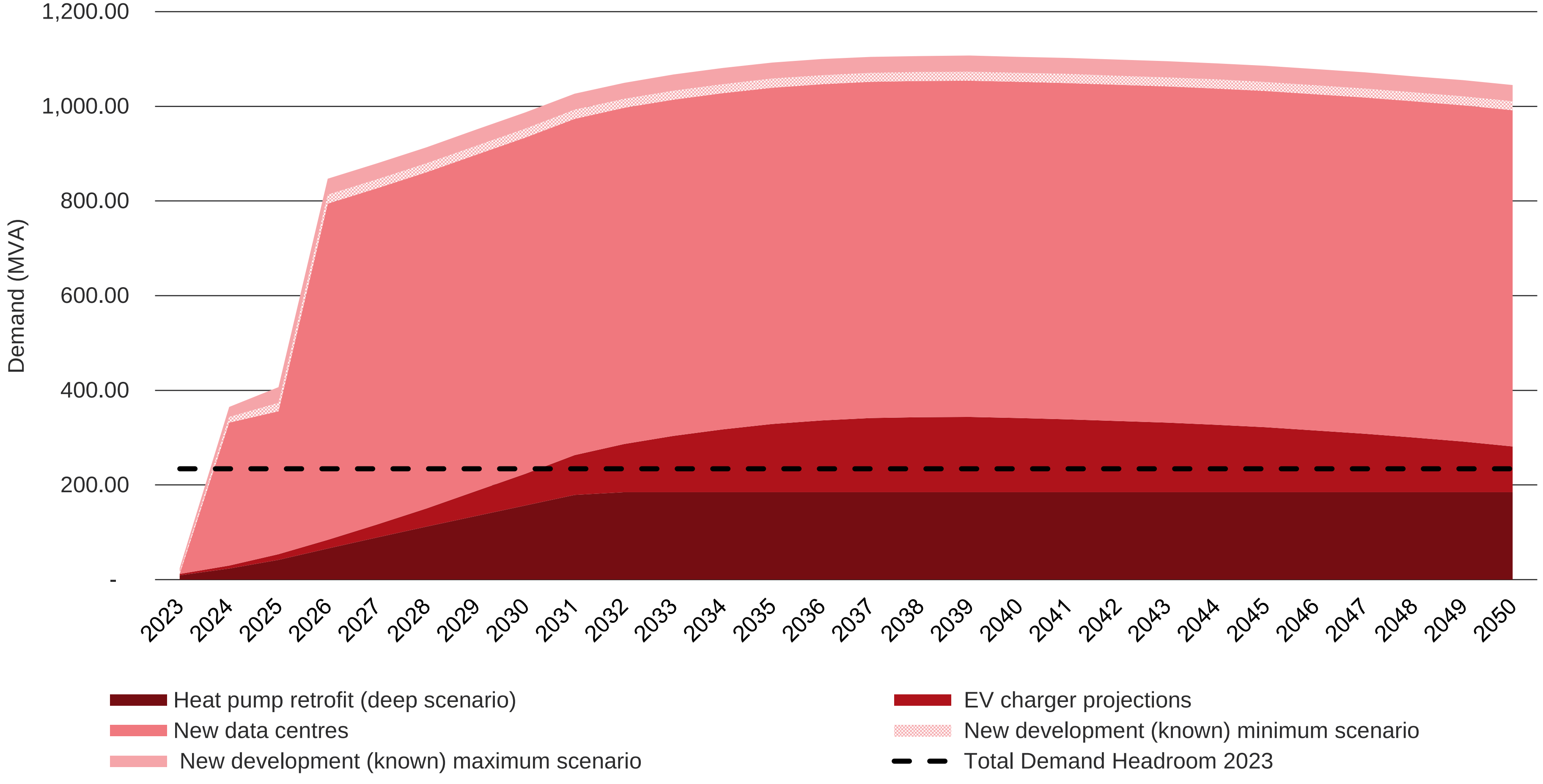
Demand Projections
Hammersmith and Fulham



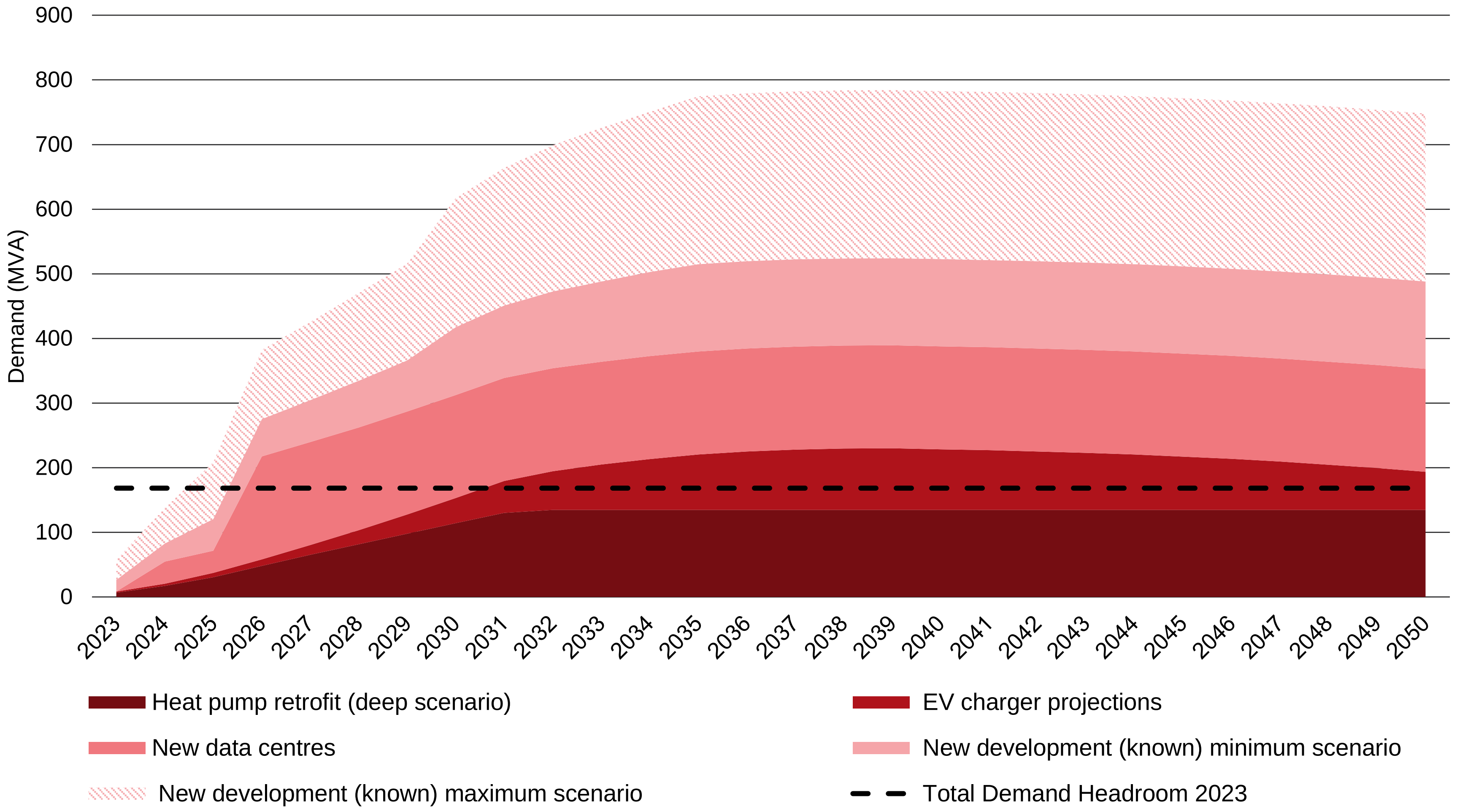
Demand Projections
Harrow



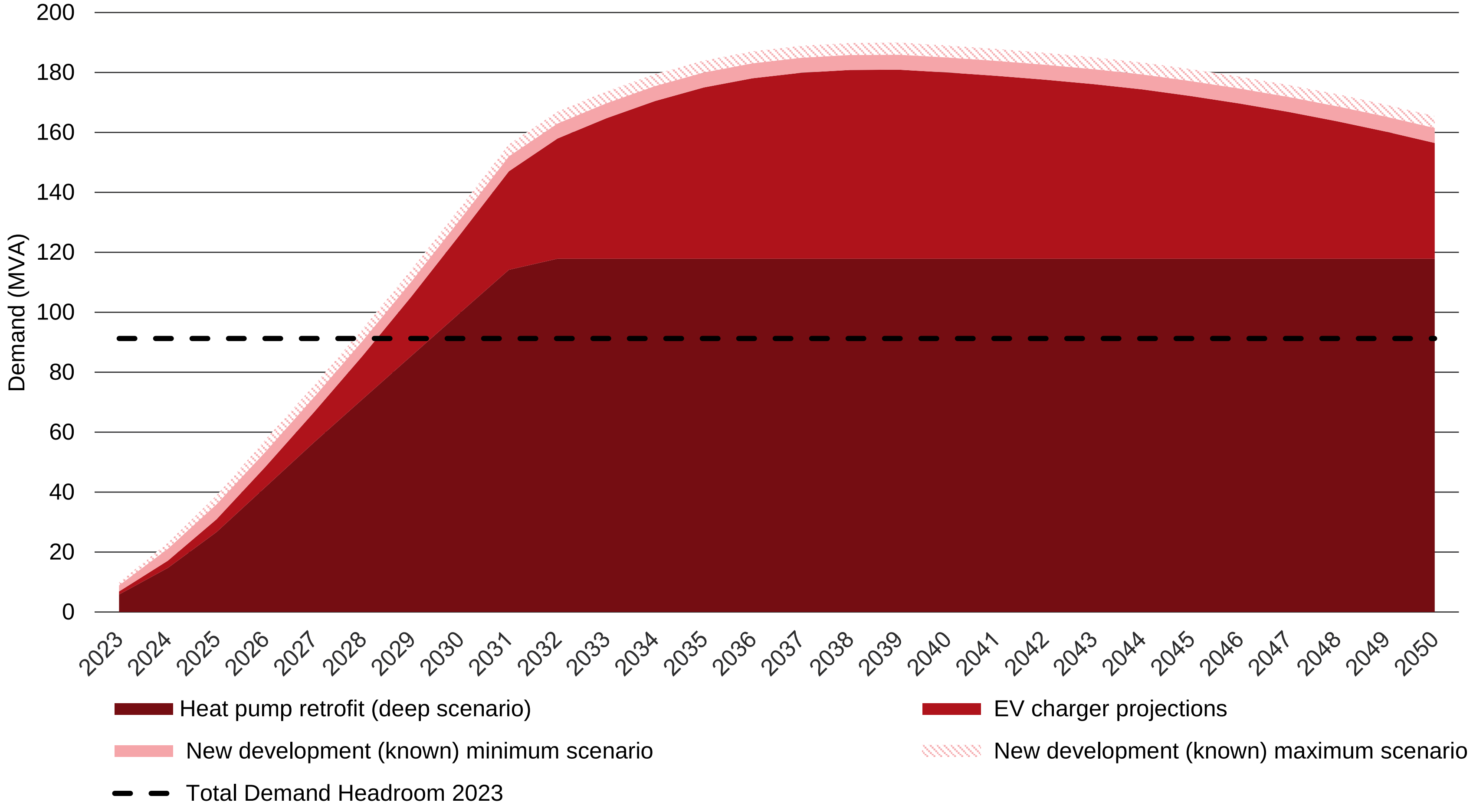
Demand Projections
Hillingdon



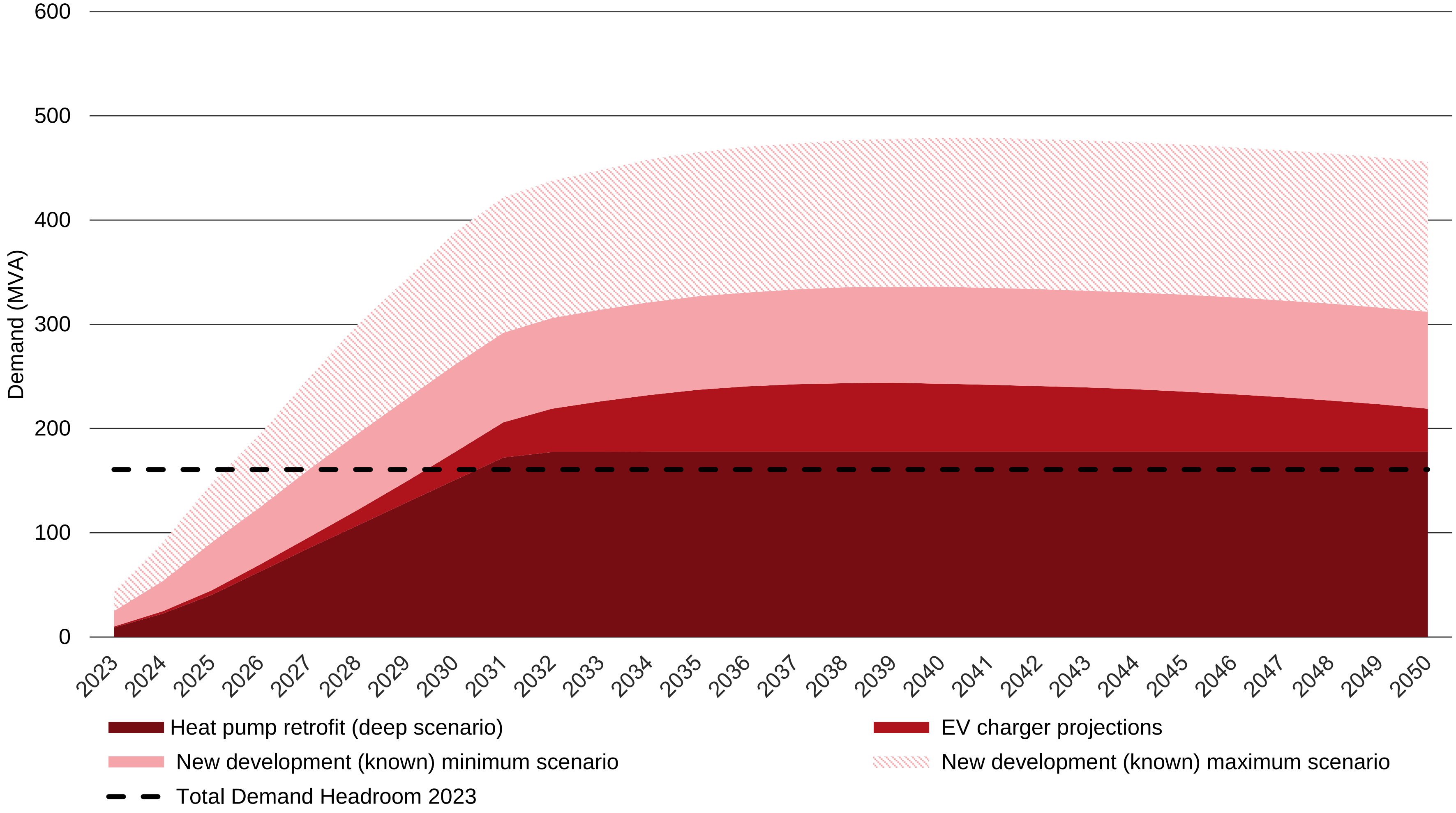
Demand Projections
Hounslow



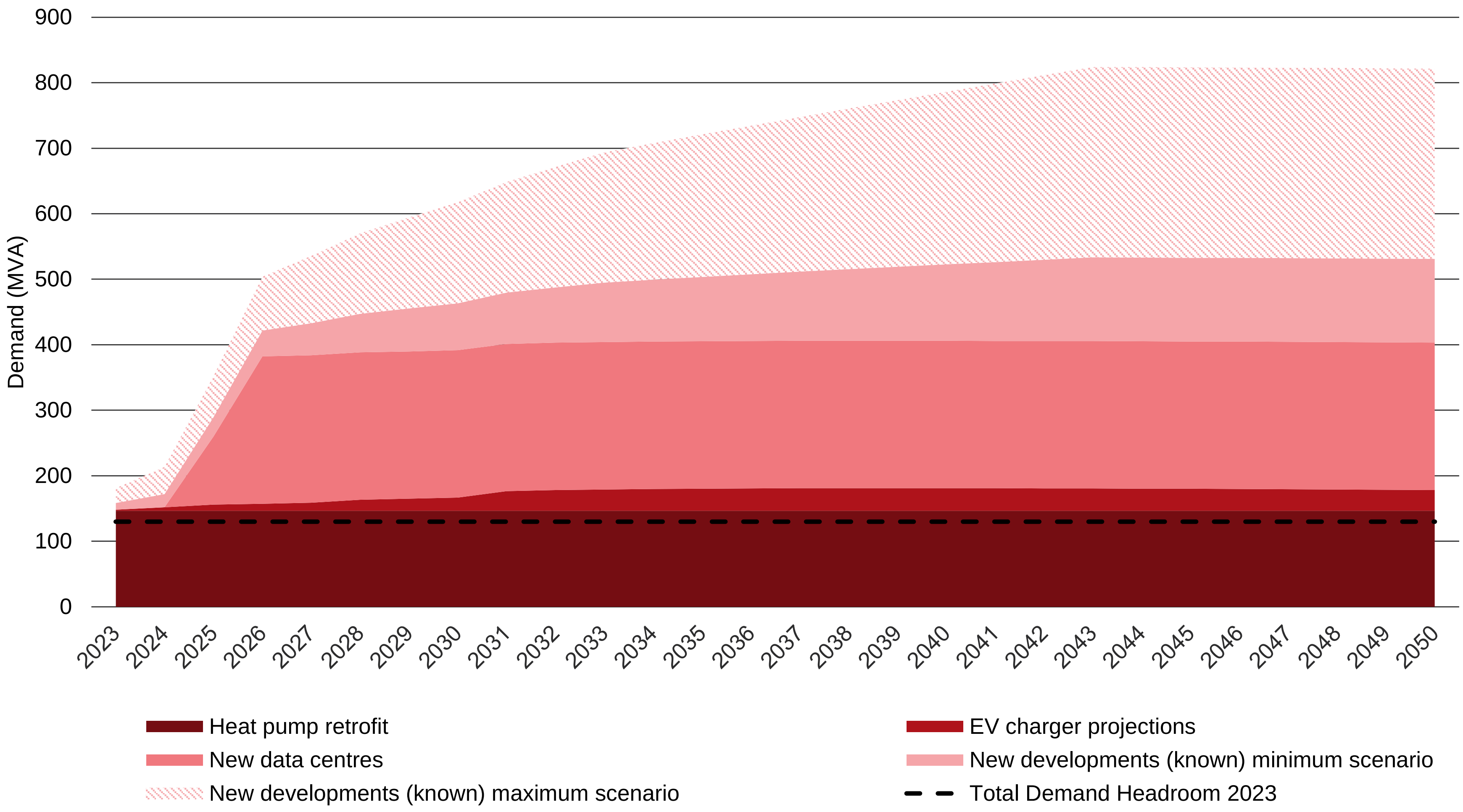
Demand Projections
Richmond upon Thames



Demand Projections
Wandsworth



Demand Projections
OPDC



ARUP

Appendix B

Borough recommendations and evidence

Borough Evidence
Barnet

Policy Intervention	Recommendation	Evidence
1. Electricity network reinforcement	1.a. Engage and collaborate with the DNO's NGET and NGESO to understand the capacity limitation in West London.	• The following primary substations have a negative demand headroom forecasted for Winter 2023; Cockfosters Primary (33/11kV), Hendon Way Primary (33/11kV), Church End Primary (33/11kV). • By 2030, East Finchley, Brokenhurt, East Barnet, Mill Hill and Manns Road Primary Substations are also forecasted to have negative demand headroom.
2. Decarbonise major energy users	2.a.Collaborate with providers or industry bodies (e.g. Tech UK) to investigate ways data centres can reduce their energy consumption and explore opportunities for waste heat offtake.	• No operational or planned data centres in borough.
	2.b.Collaborate with NHS Trusts to explore ways of reducing energy consumption and enhancing energy efficiency in healthcare sites.	• There is 1 hospital (Hadley Wood). • There are 8 other NHS sites including a community hospital, mental health hospitals and non-inpatient • Barnet's NHS sites have a total annual electricity consumption of 1.6 GWh and a total gas consumption of 1.8 GWh. This value may underestimate the actual energy consumption since the ERIC database does not contain recorded energy consumption values for all sites.
	2.c. Engage with major energy users to understand priorities and opportunities to support energy demand reduction and decarbonisation.	• Amazon moving into the Pentavia site.
3. Decarbonise transport	3.a. Deploy EV charge points in public spaces, such as offside road parking, loading bays and car parks. Encourage EV uptake amongst privately owned sector.	• Despite having the second highest annual road mileage (1,100 million miles) and number of EVs (4,149), according to data only 63 charge points have been installed in Barnet. According to Arup's model, to meet EV demand, the number of charge points will need to increase to 6,025 by 2030 and 9,035 by 2050. Referring to the LEAR tool, the following areas appear to be lacking in charge points; Ducks Island, Arkley, Mill Hill, Church End, Burnt Oak.

Borough Evidence
Barnet

Policy Intervention	Recommendation	Intervention
4. Decarbonise heat	4.a. Conduct analysis to assess the feasibility of identified heat network clusters.	• Only a small percentage of total heat demand found in a heat network cluster - under the deep retrofit scenario, 9% of the borough's heat demand is in a cluster. Heat demand clusters occur where heat demand density is higher. If building retrofit measures are less extensive than the deep retrofit scenario assumes, heat network viability would be higher.
	4.b. Investigate waste heat offtake opportunities.	• There is 1 communal boiler, 4 CHP sites and 2 low carbon plants. • Other potential waste heat sources incl. ~20 supermarkets and an incinerator. • Use of Welsh Harp water body as a heat source / thermal store.
5. Maximise local renewable generation	5.a. Map the generation potential to identify target areas for solar PV deployment.	• Barnet has the highest solar PV generation potential of 2,196 GWh. • Areas with highest potential: Hendon, Finchley Church End, Childs Hill. • The current solar installed capacity is 7.5 MW and number of installs is 1,876.
6. Energy efficiency upgrades in buildings	6.a. Identify target areas for domestic retrofit.	• In Barnet, 31% of domestic properties have an EPC rating of C, 37% are rated D and 14% are rated E. • There are LSOAs in Burnt Oak and Cricklewood that have an average EPC rating of D and a higher percentage of households in fuel poverty.
	6.b. Survey domestic council properties to sense check the shallow and deep retrofit scenarios.	• Barnet has an annual residential heat demand of 2,892 GWh, which is the highest demand of all boroughs. This higher demand can be attributed to Barnet having the largest number of residential buildings (77,637). • Under the shallow retrofit scenario, Barnet would see a residential heat demand reduction of 1,004GWh per annum (34.71% reduction), with the final heat demand being 1,888 GWh per annum. • Under the deep retrofit scenario, Barnet would see a residential heat reduction of 1,872 GWh per annum (64.73% reduction), with the final heat demand being 1,020 GWh per annum.

Borough Evidence
Brent

Policy Intervention	Recommendation	Evidence
1. Electricity network reinforcement	1.a. Engage and collaborate with the DNO's NGET and NGESO to understand the capacity limitation in West London, specifically in SSEN's service areas.	**UK Power Networks** • No primary substations have a negative demand headroom forecasted for Winter 2023. • By 2030, Kimberly Road and Kingsbury Primary (33/11kV) are forecasted to have negative demand headroom. **SSE** • No primary substations have negative demand headroom forecast in Winter 2023. • By 2030, no primary substations are expected to have negative demand headroom.
2. Decarbonise major energy users	2.a. Collaborate with providers or industry bodies (e.g. Tech UK) to investigate ways data centres can reduce their energy consumption and explore opportunities for waste heat offtake.	• There are currently 2 operational data centres, with a total IT load of 81 MW. Notably, one of these data centres has an 80MW load - the highest individual load of all data centres in West London. • There are plans to bring 2 additional data centres online by 2026.
	2.b. Collaborate with NHS Trusts to explore ways of reducing energy consumption and enhancing energy efficiency in healthcare sites.	• There are 2 hospitals (Northwick Park and St Marks Hospital and Central Middlesex Hospital). • There are 12 other NHS site including a community hospital, mental health sites, non-inpatient sites and a support facility. • Brent's NHS sites have a total annual electricity consumption of 31.3 GWh and a total gas consumption of 47.5 GWh. This value may underestimate the actual energy consumption since the ERIC database does not contain recorded energy consumption values for all sites.
	2.c. Engage with major energy users to understand priorities and opportunities to support energy demand reduction and decarbonisation.	• McVitie's factory, operated by United Biscuits (UK) Limited, is located in Harlesden. This site has an estimated annual gas consumption of 0.23 GWh. Electricity consumption is unknown. • Taylor's Lane is a gas oil power plant located in Willesden and operated by Uniper UK Limited. This site has an estimated gas consumption of 2.5 GWh. Electricity consumption is unknown. • The annual gas consumption has been calculated based on NAEI point source emission values.
3. Decarbonise transport	3.a. Deploy EV charge points in public spaces, such as offside road parking, loading bays and car parks. Encourage EV uptake amongst privately owned sector.	• There are currently 394 charge points installed in Brent. According to Arup's model, to meet EV demand, the number of charge points will need to increase to 3,754 by 2030 and 5,792 by 2050. • There are 2,359 EVs in Brent. • Total annual road mileage is 616 million miles.

Borough Evidence
Brent

Policy intervention	Recommendation	Evidence
4. Decarbonise heat	4.a. Conduct analysis to assess the feasibility of identified heat network clusters.	• Under the deep retrofit scenario, 29% of the borough's heat demand is in a cluster. • Larger clusters identified around Park Royal (OPDC) and Wembley Stadium area.
	4.b. Investigate wate heat offtake opportunities.	• There is 1 CHP site, 1 EfW, 1 EUETS and 1 Powerplant. • Other potential waste heat sites incl. ~ 10 supermarkets, 1 food and drink site (United Biscuits (UK) Limited T/A Pladis) and 2 data centres.
5. Maximise local renewable generation	5.a. Map the generation potential to identify target areas for solar PV deployment.	• Brent has a solar PV generation potential of 1,755 GWh. • The current installed capacity is 6.8 MW and number of installs is 1,206. • Areas with most potential are Stonebridge, Dolls Hill and Queens Park.
6. Energy efficiency upgrades in buildings	6.a. Identify target areas for domestic retrofit.	• In Brent, 27% of domestic properties have an EPC rating of C, 37% are rated D and 11% are rated E. • There are LSOAs in Harlesden and Neasden that have an average EPC rating of D and a higher percentage of households in fuel poverty.
	6.b. Survey domestic council properties to sense check the shallow and deep retrofit scenarios.	• Brent has an annual residential heat demand of 1,888 GWh. • Under the shallow retrofit scenario, Brent would see a residential heat demand reduction of 659 GWh per annum (34.9% reduction), with the final heat demand being 1,229 GWh. • Under the deep retrofit scenario, Brent would see a residential heat reduction of 1,234 GWh per annum, with the final demand being 653 GWh per annum (65.37%).

Borough Evidence
Ealing

Policy Intervention	Recommendation	Evidence
1. Electricity network reinforcement	1.a. Engage and collaborate with the DNO's NGET and NGESO to understand the capacity limitation in West London, specifically in SSEN's service areas.	• If a projects nearest GSP is Willesden, North Hyde or Laleham, 1MVA ramping can start now. • If projects nearest GSP is Ealing 66kV, it will need to await the distribution upgrade in 2026, before it can start ramping. • If projects nearest GSP is Iver 66kV, it will need await the distribution upgrades scheduled for 2027, before it can start the 1MVA ramping. • If a project cannot ramp up by 1 MVA per financial year, it will need to await Transmission level upgrades to be completed in 2037. • Unknown as no forecasted headroom for Lime Street 52 North 33kV and Lime Street 52 East 33kV primary substations. • No primary substations have negative demand headroom forecast in Winter 2023. • By 2030, Leamington Park primary substation is forecasted to have negative demand headroom.
2. Decarbonise major energy users	2.a. Collaborate with providers or industry bodies (e.g. Tech UK) to investigate ways data centres can reduce their energy consumption and explore opportunities for waste heat offtake.	• There are currently 6 operational data centres, with a total IT load of 50 MW. • There are plans to bring 9 more planned data centres online by 2026, increasing the IT load to 367MW. • These data centres, both operational and planned, are predominantly concentrated in OPDC.
	2.b. Collaborate with NHS Trusts to explore ways of reducing energy consumption and enhancing energy efficiency in healthcare sites.	• There is 1 hospital (Ealing Hospital). • There are 13 other NHS sites including a community hospital, mental health hospitals and non-inpatient sites. • Ealing's NHS sites have total annual electricity consumption of 9.1 GWh and a total gas consumption of 15.5 GWh. This value may underestimate the actual energy consumption since the ERIC database does not contain recorded energy consumption values for all sites.
	2.c. Engage with major energy users to understand priorities and opportunities to support energy demand reduction and decarbonisation.	• Southall Ready Meals Factory is operated by Noon Products Limited. This site has an estimated annual gas consumption of 6 GWh. Electricity consumption is unknown. • The annual gas consumption has been calculated based on NAEI point source emission values.
3. Decarbonise transport	3.a. Deploy EV charge points in public spaces, such as offside road parking, loading bays and car parks. Encourage EV uptake amongst privately owned sector.	• Ealing have a manifesto to install 2,00 charge points by 2026. • There are currently 197 charge points in Ealing. According to Arup's model, to meet EV demand, the number of charge points will need to increase to 3,971 by 2030 and 6,121 by 2050. - The are a lower number of EVs in Ealing (2,226), relative to the borough's annual road mileage (824 million miles).

Borough Evidence
Ealing

Policy Intervention	Recommendation	Evidence
4. Decarbonise heat	4.a. Conduct analysis to assess the feasibility of identified heat network clusters.	• Under the deep retrofit scenario, 26% of the borough's heat demand is in a cluster. • Larger cluster identified around Greenford Park and Ealing Broadway.
	4.b. Investigate wate heat offtake opportunities.	• There is 1 CHP and 1 Powerplant. • Other potential waste heat sites incl. ~ 13 supermarkets, 1 food and drink site (Southall Ready Meals Factory) and 6 data centres.
5. Maximise local renewable generation	5.a. Map the generation potential to identify target areas for solar PV deployment and explore alternative methods to overcome gaps in LiDAR data.	• Ealing has a solar PV generation potential of 1,982 GWh. • Areas with most potential are North Action, Central Greenford and Norwood Green. • The current installed capacity is 10.8 MW (highest of all boroughs) and number of installs is 2,278. Restrictions in LiDAR data mean the Solar Opportunity Map does not include data for the whole of Ealing. Refer to the LEAR tool to see proportion of data that is missing.
6. Energy efficiency upgrades in buildings	6.a. Identify target areas for domestic retrofit.	• In Ealing, 30% of domestic properties have an EPC rating of C, 40% are rated D and 12% are rated E. • There are LSOAs in Yeading and North Acton that have an average EPC rating of D and a higher percentage of households in fuel poverty.
	6.b. Survey domestic council properties to sense check the shallow and deep retrofit scenarios.	• Ealing has an annual residential heat demand of 2,070 GWh. • Under the shallow retrofit scenario, Ealing would see a residential heat demand reduction of 720 GWh per annum (34.8% reduction), with the final heat demand being 1,349 GWh. • Under the deep retrofit scenario, Ealing would see a residential heat reduction of 1,376 GWh per annum, with the final heat demand being 693 GWh per annum (66.47% reduction).

Borough Evidence
Hammersmith & Fulham

Policy Intervention	Recommendation	Evidence
1. Electricity network reinforcement	1.a. Engage and collaborate with the DNO's NGET and NGESO to understand the capacity limitation in West London, specifically in SSEN's service areas.	• Served by only by UK Power Networks • No primary substations have negative demand headroom forecast in Winter 2023. • By 2030, no primary substations are expected to have negative demand headroom.
2. Decarbonise major energy users	2.a. Collaborate with providers or industry bodies (e.g. Tech UK) to investigate ways data centres can reduce their energy consumption and explore opportunities for waste heat offtake.	• No operational or planned data centres in borough.
	2.b. Collaborate with NHS Trusts to explore ways of reducing energy consumption and enhancing energy efficiency in healthcare sites.	• There are 3 hospitals (Charing Cross Hospital, Hammersmith Hospital and Queen Charlotte's Hospital). • There are 5 other NHS sites including mental health facilities and non-inpatient sites. • Hammersmith and Fulham's NHS sites have the highest total annual electricity consumption of 45.7 GWh and second highest gas consumption of 114 GWh. This value may underestimate the actual energy consumption since the ERIC database does not contain recorded energy consumption values for all sites.
	2.c. Engage with major energy users to understand priorities and opportunities to support energy demand reduction and decarbonisation.	• No other major energy users identified.
3. Decarbonise transport	3.a. Deploy EV charge points in public spaces, such as offside road parking, loading bays and car parks. Encourage EV uptake amongst privately owned sector.	• There are currently 1,462 charge points installed in Hammersmith and Fulham - the highest of all • Boroughs. According to Arup's model, to meet EV demand, the number of charge points will need to increase to 759 by 2030 and 1,308 - already surpassed this. • There are a higher number of EVs (3,902) in Hammersmith and Fulham. • Annual road mileage lowest (303 million miles) however, borough area is comparably smaller.

Borough Evidence
Hammersmith & Fulham

Policy Intervention	Recommendation	Evidence
4. Decarbonise heat	4.a. Conduct analysis to assess the feasibility of identified heat network clusters.	• Under the deep retrofit scenario, 62% of the borough's heat demand is in a cluster. • Large cluster identified along Royal Borough of Kensington and Chelsea Boundary. Cluster extends throughout Shepherd Bush, Hammersmith and Brook Green.
	4.b. Investigate wate heat offtake opportunities.	• There are 3 EUETS sites 2 CHP and 10 Powerplants. • Other potential waste heat sites incl. ~10 supermarkets.
5. Maximise local renewable generation	5.a. Map the generation potential to identify target areas for solar PV deployment.	• Hammersmith and Fulham has a solar PV generation potential of 1,204 GWh. • The current installed capacity is 2.1MW (lowest of all boroughs) and number of installs is 455. • It should be considered that Hammersmith and Fulham has the lowest number of buildings at ~ 34,500. • Areas with highest solar potential are Fulham Reach, College Park and Old Oak and Palace & Hurlingham.
6. Energy efficiency upgrades in buildings	6.a. Identify target areas for domestic retrofit.	• In Hammersmith and Fulham, 37% of domestic properties have an EPC rating of C, 38% are rated D and 11% are rated E. • There are LSOAs in Parsons Green and West Kensington that have an average EPC rating of D and a lower percentage of households in fuel poverty.
	6.b. Survey domestic council properties to sense check the shallow and deep retrofit scenarios.	• Hammersmith and Fulham has an annual residential heat demand of 1,634 GWh. • Under the shallow retrofit scenario, Hammersmith and Fulham would see a heat reduction of 572 GWh per annum (35.02% reduction), with the final heat demand being 1,061 GWh. • Under the deep retrofit scenario, Hammersmith and Fulham would see a residential heat demand reduction of 921 GWh per annum (56.36% reduction), with the final heat demand being 713 GWh per annum.

Borough Evidence
Harrow

Policy Intervention	Recommendation	Evidence
1. Electricity network reinforcement	1.a. Engage and collaborate with the DNO's NGET and NGESO to understand the capacity limitation in West London, specifically in SSEN's service areas.	• No primary substations have negative demand headroom forecast in Winter 2023. • By 2030, South Harrow 33/11kV is forecasted to have negative demand headroom.
2. Decarbonise major energy users	2.a. Collaborate with providers or industry bodies (e.g. Tech UK) to investigate ways data centres can reduce their energy consumption and explore opportunities for waste heat offtake.	• No operational or planned data centres in borough.
	2.b. Collaborate with NHS Trusts to explore ways of reducing energy consumption and enhancing energy efficiency in healthcare sites.	• No hospital in Harrow. • There are 5 NHS sites including mental health and non-inpatient sites. • Harrow's NHS sites have the lowest total annual electricity and gas consumption of 1 GWh and 0.3 GWh, respectively. This value may underestimate the actual energy consumption since the ERIC database does not contain recorded energy consumption values for all sites.
	2.c. Engage with major energy users to understand priorities and opportunities to support energy demand reduction and decarbonisation.	• No other major energy users identified.
3. Decarbonise transport	3.a. Deploy EV charge points in public spaces, such as offside road parking, loading bays and car parks. Encourage EV uptake amongst privately owned sector.	• There are currently 56 EV charge points in Harrow. According to Arup's model, to meet EV demand, the number of charge points will need to increase to 4,156 by 2030 and 6,117 by 2050. Referring to the LEAR tool, the following areas appear to be lacking in charge points; Belmont, Canons Park, Headstone. • Harrow has a lower number of EVs in comparison to the other Boroughs (1,719). However, annual road mileage is also lower at 402 million miles.

Borough Evidence
Harrow

Policy Intervention	Recommendation	Evidence
4. Decarbonise heat	4.a. Conduct analysis to assess the feasibility of identified heat network clusters.	• Only a small percentage of demand found in a cluster - under the deep retrofit scenario, 11% of the borough's heat demand is in a cluster.
	4.b. Investigate wate heat offtake opportunities.	• There is 1 CHP site and 1 communal boiler. • Other potential waste heat sites incl. ~13 supermarkets and 1 chemical site (Kodak Alaris Ltd).
5. Maximise local renewable generation	5.a. Map the generation potential to identify target areas for solar PV deployment and explore alternative methods to overcome gaps in LiDAR data.	• Harrow has a solar PV generation potential of 1,370 GWh. • The current installed capacity is 5.4MW and number of installs is 1,265. • Areas with most potential are North Acton, Central Greenford and Hanger Hill. • Restrictions in LiDAR data mean the Solar Opportunity Map does not include data for the whole of Ealing. Refer to the LEAR tool to see proportion of data that's missing.
6. Energy efficiency upgrades in buildings	6.a. Identify target areas for domestic retrofit.	• In Harrow, 28% of domestic properties have an EPC rating Band C, 41% are rated D and 15% are rated E. • There are LSOAs in South Harrow and West Harrow that have an average EPC rating of D and a higher percentage of households in fuel poverty.
	6.b. Survey domestic council properties to sense check the shallow and deep retrofit scenarios.	• Harrow has an annual residential heat demand of 1,613 GWh. • Under the shallow retrofit scenario, Harrow would see a residential heat demand reduction of 563 GWh per annum (34.91%), with the final heat demand being 1,050 GWh. • Under the deep retrofit scenario, Harrow would see a residential heat demand reduction of 1,071 GWh per annum (66.36% reduction), with the final heat demand being 543 GWh per annum.

Borough Evidence
Hillingdon

Policy Intervention	Recommendation	Evidence
1. Electricity network reinforcement	1.a. Engage and collaborate with the DNO's NGET and NGESO to understand the capacity limitation in West London, specifically in SSEN's service areas.	• If a projects nearest GSP North Hyde, 1MVA ramping can start now. • If projects nearest GSP is Iver 132kV/66kV, it will need await the distribution upgrades scheduled for 2027, before it can start the 1MVA ramping. • If a project cannot ramp up by 1 MVA per financial year, it will need to await Transmission level upgrades to be completed in 2037.
		UK Power Networks • No primary substations have negative demand headroom forecast in Winter 2023. • By 2030, no primary substations are expected to have negative headroom. **SSEN** • No primary substations have negative demand headroom forecast in Winter 2023. • By 2030, Hillingdon, North Hyde 11 and Springfield road are all forecast to have negative demand headroom.
2. Decarbonise major energy users	2.a. Collaborate with providers or industry bodies (e.g. Tech UK) to investigate ways data centres can reduce their energy consumption and explore opportunities for waste heat offtake.	• There are currently 8 operational data centres with a total IT load of 109 MW - the highest total IT load of all boroughs. • There are 17 more that are planned to be operational by 2026, increasing the total count of data centres to 25. The IT load if expected to increase to 682 MW - again, the highest IT load of all boroughs.
	2.b. Collaborate with NHS Trusts to explore ways of reducing energy consumption and enhancing energy efficiency in healthcare sites.	• There is 1 hospital (Harefield Hospital). • There are 7 other NHS sites including mental health and non-inpatient sites. • Hillingdon's NHS sites have a total annual electricity consumption of 7 GWh and a total gas consumption of 109.4 GWh. • This value may underestimate the actual energy consumption since the ERIC database does not contain recorded energy consumption values for all sites.
	2.c. Engage with major energy users to understand priorities and opportunities to support energy demand reduction and decarbonisation.	• Heathrow Airport is operated by Heathrow Airport Holdings Limited. This site has annual electricity consumption of 453 GWh. This figure does not include electricity consumption from the EV provisions. • It is expected that Heathrow Airport's annual electricity consumption would increase by at least 50% to decarbonise buildings, infrastructure and operational fleet.

Borough Evidence
Hillingdon

Policy Intervention	Recommendation	Evidence
3. Decarbonise transport	3.a. Deploy EV charge points in public spaces, such as offside road parking, loading bays and car parks. Encourage EV uptake amongst privately owned sector.	• Despite having the highest annual road milage (1,520 million miles), and highest number of EVs (6,094), only 141 charge points have been installed in Hillingdon. According to Arup's model, to meet EV demand, the number of charge points will need to increase to 7,335 in 2030 and 10,741 in 2050 - this is the largest increase required across all boroughs. Referring to the LEAR tool, areas lacking in charge points include; Eastcote, West Ruislip and Harefield.
4. Decarbonise heat	4.a. Conduct analysis to assess the feasibility of identified heat network clusters.	• Under the deep retrofit scenario, 34% of the borough's heat demand is in a cluster. • Larger cluster identified in and around Heathrow airport. Other cluster around Stockley, near Prologis Park West London (data centres) and Abenglen Industrial estate.
	4.b. Investigate wate heat offtake opportunities.	• There are 11 CHP sites. • Other potential waste heat sites incl. 3 mineral industries (Hanson Quarry Products Europe Ltd, Aggregate Industries UK Ltd and Tarmac Trading Ltd), ~ 14 supermarkets and 8 data centres.
5. Maximise local renewable generation	5.a. Map the generation potential to identify target areas for solar PV deployment and explore alternative methods to overcome gaps in LiDAR data.	• Hillingdon has a solar PV generation potential of 2,193 GWh - second highest despite missing data. • The current installed capacity is 8.6MW and number of installs at 1,625. • Areas with most potential are Heathrow Village, Uxbridge and Colham & Cowley.
6. Energy efficiency upgrades in buildings	6.a. Identify target areas for domestic retrofit.	• In Hillingdon, 29% of domestic have an EPC rating of C, 42% are rated D and 14% are rated E. • There are LSOAs in Hillingdon Heath that have an average EPC rating of D and a higher percentage of households in fuel poverty.
	6.b. Survey domestic council properties to sense check the shallow and deep retrofit scenarios.	• Hillingdon has an annual residential heat demand of 1,658 GWh. • Under the shallow retrofit scenario, Hillingdon would see a residential heat demand reduction of 578 GWh per annum (34.84% reduction), with the final heat demand being 1,080 GWh. • Under the deep retrofit scenario, Hillingdon was see a residential heat demand reduction of 1,083 GWh per annum (65.31% reduction), with the final heat demand being 575 GWh per annum.

Borough Evidence
Hounslow

Policy Intervention	Recommendation	Evidence
1. Electricity network reinforcement	1.a. Engage and collaborate with the DNO's NGET and NGESO to understand the capacity limitation in West London, specifically in SSEN's service areas.	• If a projects nearest GSP North Hyde or Laleham, 1MVA ramping can start now. • If projects nearest GSP is Ealing 66kV, it will need to await the distribution upgrade in 2026, before it can start ramping. • If a project cannot ramp up by 1 MVA per financial year, it will need to await Transmission level upgrades to be completed in 2037.
	1.b. Engage and collaborate with the DNO's NGET and NGESO to understand the capacity limitation in West London, specifically in SSEN's service areas.	• No primary substations have negative demand headroom forecast in Winter 2023. • By 2030, North Feltham is forecast to have negative demand headroom.
2. Decarbonise major energy users	2.a. Collaborate with providers or industry bodies (e.g. Tech UK) to investigate ways data centres can reduce their energy consumption and explore opportunities for waste heat offtake.	• There are currently 6 operational data centres with a total IT load of 33 MW. • There is 1 more that is planned to be operational by 2026. The IT load is expected to increase to 153 MW, meaning that single planned data centre has a large IT load of 120 MW.
	2.b. Collaborate with NHS Trusts to explore ways of reducing energy consumption and enhancing energy efficiency in healthcare sites.	• There is 1 hospital (West Middlesex Hospital). • There is 1 other NHS sites including support facility. • Hounslow's NHS sites have a total electricity consumption of 8 GWh and a total gas consumption of 14.3 GWh.
	2.c. Engage with major energy users to understand priorities and opportunities to support energy demand reduction and decarbonisation.	• Muller operate a dairy factory in Hanworth. This site has an estimated gas consumption of 4.4 GWh. Electricity consumption is unknown. • The annual gas consumption has been calculated based on NAEI point source emission values.
3. Decarbonise transport	3.a. Deploy EV charge points in public spaces, such as offside road parking, loading bays and car parks. Encourage EV uptake amongst privately owned sector.	• There are currently 323 charge points installed in Hounslow. According to Arup's model, to meet EV demand, the number of charge points will need to increase to 3,955 by 2030 and 6,076 by 2050. • Hounslow has the lowest number of EVs (1,711), despite having a high road mileage of 1,062 million miles.

Borough Evidence
Hounslow

Policy Intervention	Recommendation	Evidence
4. Decarbonise heat	4.a. Conduct analysis to assess the feasibility of identified heat network clusters.	• Under the deep retrofit scenario, 30% of the borough's heat demand is in a cluster. • Larger cluster identified around Brentford.
	4.b. Investigate wate heat offtake opportunities.	• There are 5 CHP sites and 1 communal boiler site. • Other potential waste heat sites include a sewage treatment plant (Modgen Sewage Treatment Works) and 1 food and drink site (Dairy Crest Ltd), and 6 operational data centres.
5. Maximise local renewable generation	5.a. Map the generation potential to identify target areas for solar PV deployment and explore alternative methods to overcome gaps in LiDAR data.	• Hounslow has a solar PV generation potential of 1,551 GWh. • The current installed capacity is 10.5 MW and number of installs is 1,514. • Areas with most potential are Osterley & Spring Grove, Chiswick Gunnersbury and Chiswick Homefields. • Restrictions in LiDAR data mean the Solar Opportunity Map does not include data for the whole of Hounslow. Refer to the LEAR tool to see proportion of data that's missing.
6. Energy efficiency upgrades in buildings	6.a. Identify target areas for domestic retrofit.	• In Hounslow, 33% of domestic properties have an EPC rating of C, 37% are rated D and 12% are rated E. • There are LSOAs in Hounslow West and Hanworth that have an average EPC rating of D and higher percentage of households in fuel poverty.
	6.b. Survey domestic council properties to sense check the shallow and deep retrofit scenarios.	• Hounslow has an annual residential heat demand of 1,415 GWh. • Under the shallow retrofit scenario, Hounslow would see a residential heat demand reduction of 494 GWh per annum (34.89% reduction), with the final heat demand being 921 GWh. • Under the deep retrofit scenario, Hounslow would see a residential heat demand reduction 911 GWh per annum (66.59% reduction), with the final heat demand being 504 GWh per annum.

Borough Evidence
Richmond-Upon-Thames

Policy Intervention	Recommendation	Evidence
1. Electricity network reinforcement	1.a. Engage and collaborate with the DNO's NGET and NGESO to understand the capacity limitation in West London, specifically in SSEN's service areas.	• Served by UK Power Networks only
	1.b. Engage and collaborate with the DNO's NGET and NGESO to understand the capacity limitation in West London, specifically in SSEN's service areas.	• No primary substations have negative demand headroom forecast in Winter 2023. • By 2030, no primary substations are expected to have negative demand headroom.
2. Decarbonise major energy users	2.a. Collaborate with providers or industry bodies (e.g. Tech UK) to investigate ways data centres can reduce their energy consumption and explore opportunities for waste heat offtake.	• No operational or planned data centres in borough.
	2.b. Collaborate with NHS Trusts to explore ways of reducing energy consumption and enhancing energy efficiency in healthcare sites.	• There is 1 hospital (Teddington Memorial Hospital). • There are 7 other NHS sites including mental health and non-inpatient sites. • Richmond-Upon-Thames NHS sites have a total annual electricity consumption of 1.2 GWh and a total gas consumption of 3 GWh.
	2.c. Engage with major energy users to understand priorities and opportunities to support energy demand reduction and decarbonisation.	• Kew Gardens is run by the Royal Botanic Gardens, Kew. The site has an annual electricity consumption of 7.8 GWh and an annual gas consumption of 20 GWh, making it one of the sub-regions most significant gas users.
3. Decarbonise transport	3.a. Deploy EV charge points in public spaces, such as offside road parking, loading bays and car parks. Encourage EV uptake amongst privately owned sector.	• There are currently 460 charge points installed in Richmond Upon Thames. According to Arup's model, to meet EV demand, the number of charge points will need to increase to 2,643 by 2030 and 3,951 by 2050. • There are 2,378 EVs in Richmond Upon Thames. • Annual road mileage of 525 million miles.

Borough Evidence
Richmond upon Thames

Policy Intervention	Recommendation	Evidence
4. Decarbonise heat	4.a. Conduct analysis to assess the feasibility of identified heat network clusters.	• Only a small percentage of demand found in a cluster - under the deep retrofit scenario, 17% of the borough's heat demand is in a cluster.
	4.b. Investigate wate heat offtake opportunities.	• There is 1 CHP sites and 1 significant supply site (the Stag Brewery). • Other potential waste heat sites incl. ~13 supermarkets.
5. Maximise local renewable generation	5.a. Map the generation potential to identify target areas for solar PV deployment.	• Richmond-Upon-Thames has a solar generation PV potential of 1,281 GWh. • The current installed capacity is 4.7 MW and number of installs is 1,379 . • Areas with the most potential are South Richmond, St Margaret & North Twickenham and Teddington.
6. Energy efficiency upgrades in buildings	6.a. Identify target areas for domestic retrofit.	• In Richmond-Upon-Thames, 30% of properties have an EPC rating of C, 42% are rated D and 18% are rated E. • There are no specific target areas identified as the percentage of households in fuel poverty is generally quite low across the borough. Richmond-Upon-Thames has the lowest proportion of household in fuel poverty (8%).
	6.b. Survey domestic council properties to sense check the shallow and deep retrofit scenarios.	• Richmond-Upon-Thames has an annual residential heat demand of 15,97 GWh. • Under the shallow retrofit scenario, Richmond-Upon-Thames would see a residential heat reduction of 553 GWh per annum (34.60% reduction), with the final heat demand being 1,044 GWh. • Under the deep retrofit scenario, Richmond-Upon-Thames would see a residential heat demand reduction of 1,063 GWh per annum (66.59% reduction), with the final heat demand of 534 GWh per annum.

Borough Evidence
Wandsworth

Policy Intervention	Recommendation	Evidence
1. Electricity network reinforcement	1.a. Engage and collaborate with the DNO's NGET and NGESO to understand the capacity limitation in West London, specifically in SSEN's service areas.	• No primary substations have negative demand headroom forecast in Winter 2023. • By 2030, no primary substations are expected to have negative demand headroom.
2. Decarbonise major energy users	2.a. Collaborate with providers or industry bodies (e.g. Tech UK) to investigate ways data centres can reduce their energy consumption and explore opportunities for waste heat offtake.	• No operational or planned data centres in borough.
	2.b. Collaborate with NHS Trusts to explore ways of reducing energy consumption and enhancing energy efficiency in healthcare sites.	• There are 3 hospitals (St George's Hospital, Springfield University Hospital and Queen Mary's Hospital). • There are 3 other NHS sites including a community hospital, a specialist hospital and a other reportable site. • Wandsworth's NHS sites have the highest total annual gas consumption at 141.4 GWh. The total annual electricity consumption is 12.6 GWh. This value may underestimate the actual energy consumption since the ERIC database does not contain recorded energy consumption values for all sites.
	2.c. Engage with major energy users to understand priorities and opportunities to support energy demand reduction and decarbonisation.	• No other major energy users identified.
3. Decarbonise transport	3.a. Deploy EV charge points in public spaces, such as offside road parking, loading bays and car parks. Encourage EV uptake amongst privately owned sector.	• There are currently 756 charge points installed in Wandsworth - the second highest of all Boroughs. • According to Arup's model, to meet EV demand, the number of charge points will need to increase to 1,473 by 2030 and 2,408 by 2050. • There are 2,918 EVs in Wandsworth. • Annual road mileage is lower at 470 million miles.

Borough Evidence
Wandsworth

Policy Intervention	Recommendation	Evidence
4. Decarbonise heat	4.a. Conduct analysis to assess the feasibility of identified heat network clusters.	• Under the deep retrofit scenario, 34% of the borough's heat demand is in a cluster. • Larger clusters identified round Battersea and Nine Elms.
	4.b. Investigate wate heat offtake opportunities.	• There is 1 Boiler and CHP sites, 5 CHP sites, 3 communal boilers and 2 EUETS sites. • Other potential waste heat sites incl. ~17 supermarkets.
5. Maximise local renewable generation	5.a. Map the generation potential to identify target areas for solar PV deployment.	• Wandsworth has a solar PV potential generation of 1,982 GWh. • The current installed capacity is 5.2 MW and number of installs at 1,121. • Areas with the most potential are Tooting Broadway, Wandsworth Town and Wandsworth Common.
6. Energy efficiency upgrades in buildings	6.a. Identify target areas for domestic retrofit.	• In Wandsworth, 35% of properties have an EPC rating of C,36% are rated D and 11% are rated E. • There are LSOAs in Streatham Park, Tooting Common and Putney Value that have average EPC ratings of D and a higher percentage of households in fuel poverty.
	6.b. Survey domestic council properties to sense check the shallow and deep retrofit scenarios.	• Wandsworth has an annual residential heat demand of 2,244 GWh. • Under the shallow retrofit scenario, Wandsworth would see a heat demand reduction of 778 GWh per annum (34.7% reduction), with the final heat demand being 1,466 GWh. • Under the deep retrofit scenario, Wandsworth would see a residential heat demand reduction of 1,465 GWh per annum (65.2% reduction), with the final heat demand being 780 GWh per annum.

Borough Evidence
OPDC

Policy Intervention	Recommendation	Evidence
1. Electricity network reinforcement	1.a. Engage and collaborate with the DNO's NGET and NGESO to understand the capacity limitation in West London, specifically in SSEN's service areas.	• If a projects nearest GSP is Willesden, 1MVA ramping can start now. • If a project cannot ramp up by 1 MVA per financial year, it will need to await Transmission level upgrades to be completed in 2037.
	1.b. Engage and collaborate with the DNO's NGET and NGESO to understand the capacity limitation in West London, specifically in SSEN's service areas.	**UK Power Networks** • No primary substations have negative demand headroom forecast in Winter 2023. • By 2030, no primary substations are expected to have negative demand headroom. **SSEN** • No primary substations have negative demand headroom forecast in Winter 2023. • By 2030, North Feltham is forecast to have negative demand headroom.
2. Decarbonise major energy users	2.a. Collaborate with providers or industry bodies (e.g. Tech UK) to investigate ways data centres can reduce their energy consumption and explore opportunities for waste heat offtake.	• There are currently 5 operational data centres with a total IT load of 45.6 MW load. • There are 5 more data centres that are planned to be operational by 2026. The IT load is expected to increase by 232 MW.
	2.b. Collaborate with NHS Trusts to explore ways of reducing energy consumption and enhancing energy efficiency in healthcare sites.	• There is 1 hospital in the OPDC region (Central Middlesex Hospital). • The hospital has an annual electricity consumption of 6.9 GWh and a gas consumption of 9.6 GWh.
	2.c. Engage with major energy users to understand priorities and opportunities to support energy demand reduction and decarbonisation.	• No other major energy users identified.
3. Decarbonise transport	3.a. Deploy EV charge points in public spaces, such as offside road parking, loading bays and car parks. Encourage EV uptake amongst privately owned sector.	• Data only available at Borough level.

Borough Evidence
OPDC

Policy Intervention	Recommendation	Evidence
4. Decarbonise heat	4.a. Conduct analysis to assess the feasibility of identified heat network clusters.	• Under the deep retrofit scenario, 51% of the borough's heat demand is in a cluster. • Large cluster in OPDC covering Park Royal area.
	4.b. Investigate wate heat offtake opportunities.	• There is 1 food and drink site (United Biscuits UK Limited), 1 supermarket and 5 operational data centres.
5. Maximise local renewable generation	5.a. Map the generation potential to identify target areas for solar PV deployment.	• Data only available at Borough level.
6. Energy efficiency upgrades in buildings	6.a. Identify target areas for domestic retrofit.	• Data only available at Borough level.
	6.b. Survey domestic council properties to sense check the shallow and deep retrofit scenarios.	• OPDC has an annual residential heat demand of 26 GWh. Unlike the boroughs, demand from commercial/public buildings account for the majority of the area's heat demand (61%).

Appendix C

Key assumptions

Borough Evidence
Retrofit scenario assumptions

Skenario Labs Methodology

Baselining

To gain insights into the current operational energy use of a building, Skenario Labs classified buildings into archetypes based on their construction year, material, and purpose. Each archetype has a unique set of parameters including, U-values and domestic hot water demand. The projected area of a building's polygon, floor count and other building features are used to estimate its area and shape. Skenario Labs' methodology uses the ISO 52016-1:2017 standard to quantify heating and cooling demands, taking into account variations in weather and occupancy patterns.

Scenario Modelling

Using the baseline, Skenario Labs have modelled energy demand changes under a Deep and Shallow retrofit scenario. Table C.1 shows the intervention measures applied to each retrofit scenario, with measures broadly covering, building automation, building services and building fabric improvements. Note, intervention measures were not relevant for all building types. For example, 'recommissioning ventilation' was not applied to detached, semi-detached and terraced properties. See full break down in Table C.2 overleaf.

Intervention measures	Deep retrofit	Shallow retrofit
Building automation covering, health check on controls and/or BMS, installing energy meters, installing system specific energy sub-meters, energy consumption monitoring and lighting controls	Applied	Applied
Recommissioning of ventilation	Applied	
Recommissioning of cooling systems	Applied	Applied
Replace ventilation units + hru		Applied
Incorporate VSDs to HVAC motors	Applied	Applied
Power factor correction	Applied	Applied
Check/repair ductwork leakage	Applied	Applied
Luminaire replacement (to LED's & high frequency ballasts)	Applied	Applied
Renew heat distribution (if required e.g. due to lower temperature inflow with heat pumps)		Applied
Internal solar control devices (blinds)	Applied	Applied
External solar control devices (brie solei, light shelves, etc)		Applied
Replacement of/additional glazing	Applied	
Replace windows (U-value & g-value)		Applied
Improve external wall insulation		Applied
Air tightness improvements and Roof/loft insulation	Applied	Applied
Mineral wool insulation below floor		Applied

Table C.1: Intervention measures applied to each retrofit scenario.

Borough Evidence
Retrofit scenario assumptions

Intervention	Detached house	Semi-detached /terraced	Apartments	Office	Assembly building	Hotel	Industrial	Retail	School	Warehouse
Building automation / BMS										
Health check on controls and/or BMS			x	x	x	x	x	x	x	x
Install incoming utility (gas/elec/water) energy meters		x	x	x	x	x	x	x	x	x
Install system specific energy sub-meters (e.g. distribution board level)			x	x	x	x	x	x	x	x
Calibrate building temperature set points	x	x	x	x	x	x	x	x	x	x
Targeted energy consumption monitoring			x	x	x	x	x	x	x	x
Lighting controls (programmable, daylight/occupancy linked)			x	x	x	x	x	x	x	x
Building services interventions										
Recommissioning of ventilation			x	x	x	x	x	x	x	x
Recommissioning of cooling systems				x	x	x	x	x	x	
Replace ventilation units + hru			x	x	x	x	x	x	x	x
Incorporate VSDs to HVAC motors				x	x	x	x	x		
Power factor correction				x	x	x	x	x		

Table C.2: Intervention measures applied to each building archetype.

Borough Evidence
Retrofit scenario assumptions

Intervention	Detached house	Semi-detached /terraced	Apartments	Office	Assembly building	Hotel	Industrial	Retail	School	Warehouse
Check/repair ductwork leakage			x	x	x	x	x	x	x	
Luminaire replacement (to LED's & high frequency ballasts)			x	x	x	x	x	x	x	x
Renew heat distribution (if required e.g. due to lower temperature inflow with heat pumps)	x	x	x	x	x	x	x	x	x	x
Building fabric interventions										
Internal solar control devices (blinds)	x	x	x	x	x	x		x	x	
External solar control devices (brie solei, light shelves, etc)	x	x	x	x	x	x		x		
Replacement of/additional glazing	x	x	x	x	x	x		x	x	
Replace windows (U-value & g-value)	x	x	x	x	x	x		x	x	
Improve external wall insulation	x	x	x	x	x	x	x	x	x	x
Air tightness improvements	x	x	x	x	x	x	x	x	x	x
Roof/loft insulation	x	x	x	x	x	x	x	x	x	x
Mineral wool insulation below floor	x	x	x							

Table C.3 : Intervention measures applied to each property type.

Planned Growth Assumptions

Table C.3 shows the residential unit floorspace assumptions for each borough used in the planned growth load calculations in Section 3.

The difference between the number of residential building typologies recorded in the 2011 and 2021 National Census was calculated to develop a distribution of historic change between residential building typologies in each borough. The English Housing Survey floorspace benchmark for each building typology was multiplied by this borough distribution to arrive at an estimated average floorspace value per new residential unit in each borough.

For a more detailed explanation of the planned growth load calculations, please see the detailed workflow included in the LEAR tool.

Borough	Floorspace per residential unit (m^2)
Barnet	56
Brent	55
Ealing	58
Harrow	57
Hammersmith & Fulham	55
Hillingdon	63
Hounslow	68
Richmond upon Thames	65
Wandsworth	55

Table C.3: Residential unit floorspace assumptions for each borough.

* Assumptions are used in both the maximum and minimum scenarios

Planned Growth Assumptions
Minimum Scenario - Residential

Description	Assumption	Source
Residential electrical peak	12 kW/unit	UK Power Networks C1 report, average peak value
Residential electrical diversity	UK Power Networks C1 Report diversity curves	UK Power Networks C1 Report
Residential space heating peak	0.02 kWth/m^2	Arup assumption
Residential space heating diversity	0.85	Arup assumption
Residential domestic hot water peak	DS439 standard	CP1
Residential cooling peak	0.015 kWth/m^2	BRISA, Rule of Thumb
Residential cooling diversity	0.85	Arup assumption
Air-source heat pump COP *	1.7	SAP methodology
Cooling EER *	3	Part L2
Power factor *	0.96	Industry standard assumption

* Assumptions are used in both the maximum and minimum scenarios

Planned Growth Assumptions
Maximum Scenario - Residential

Description	Assumption	Source
Residential electrical peak	7.5 kW/unit	BRISA, rule of thumb
Residential electrical diversity	None	Arup assumption
Residential space heating peak	0.06 kWth/m^2	BRISA, Rule of Thumb
Residential space heating diversity	None	Arup assumption
Residential domestic hot water peak	DS439 standard	CP1
Residential cooling peak	0.07 kWth/m^2	BRISA, Rule of Thumb
Residential cooling diversity	None	Arup assumption

Planned Growth Assumptions
Minimum Scenario – Non-Residential

Description	Assumption	Source
Non-residential electrical peak	0.056 kW/m^2	Arup assumption
Non-residential space heating peak	0.035 kWth/m^2	Arup assumption
Non-residential cooling peak	0.049 kWth/m^2	Arup assumption
Non-residential diversity	0.9	Arup assumption
Air-source heat pump COP *	1.7	SAP methodology
Cooling EER *	3	Part L2
Power factor *	0.96	Industry standard assumption

* Assumptions are used in both the maximum and minimum scenarios

Planned Growth Assumptions
Maximum Scenario – Non-Residential

Non-Residential Building Typology	Heat Peak (kW/m²)	Elec Peak (kWth/m²)	Cool Peak (kWth/m²)	Source
Retail	0.1	0.16	0.14	BRISA, rule of thumb
Industrial	0.08	0.16	0.14	BRISA, rule of thumb
Office	0.07	0.087	0.087	BRISA, rule of thumb
Community, arts & leisure	0.1	0.16	0.14	BRISA, rule of thumb
Education	0.087	0.05	0.14	BRISA, rule of thumb
Storage	0.1	0.017	0.14	BRISA, rule of thumb
Hospitality	0.1	0.13	0.15	BRISA, rule of thumb
Health	0.1	0.065	0.14	BRISA, rule of thumb