BURO HAPPOLD

Westminster Local Area Energy Plan

Westminster LAEP

XXXX-BHE-XX-XX-XX-X-XXXX

0054673

7 March 2024

Revision P04

Revision	Description	Issued by	Date	Checked
P01	Final LAEP report – first draft	AC	10.11.23	BW
P02	Final LAEP report – 2nd draft	AC/MM	13.12.23	BW
P03	Final LAEP Report – 3rd draft (without grammar review or graphics update)	AC	02.02.24	BW
P04	Final LAEP report	AC	07.03.24	MMcT/AC

https://burohappold.sharepoint.com/sites/054673/02_Documents/04_Reports/Final Report/240228_Final WCC LAEP report - Final.docx

Report Disclaimer

This Report was prepared by Buro Happold Limited ("BH") for the sole benefit, use and information of Westminster City Council for Purpose of Report. BH assumes no liability or responsibility for any reliance placed on this Report by any third party for any actions taken by any third party in reliance of the information contained herein. BH’s responsibility regarding the contents of the Report shall be limited to the purpose for which the Report was produced and shall be subject to the express contract terms with Westminster City Council. The Report shall not be construed as investment or financial advice. The findings of this Report are based on the available information as set out in this Report.

approved	**Bill Wilson**
signature	
date	**02.02.24**

Section Ref	Author	Date

..

Contents

Table of Tables

Table of Figures

Glossary

Term/acronym	Definition
AHC	After Housing Costs
BIDs	Business Improvement Districts – are area in which local businesses have voted to invest together to improve their environment
BIDs	Business Improvement District
Capacity Headroom	It is the amount of unused network capacity for demand and generation. It identifies the areas where there is need for electricity grid reinforcement or there is need for flexibility services
CAPEX	Capital expenditure – provides an indication of total cost of a specific project or item.
Demand Diversity	It refers to natural differences in demand. This accounts for the fact that not everyone will be using all of their appliances at once, e.g., every household charging an EV, having a shower, cooking a meal, using the tumble dryer and having the heating on full at the same time.
DESNZ	Department for Energy Security and Net Zero
DFES	Distributed Future Energy Scenarios are more local versions of the FES produced by the distribution network operators (the relevant one to Westminster being UKPN)
DFES	Distribution Future Energy Scenarios – provide granular scenario projections that incorporate regional factors and can be used at a local level for strategic planning of electricity distribution systems and networks.
District Heat Network	It distributes heat or cooling from a central source or sources to a variety of different customers such as public buildings, shops, offices, hospitals, universities, and homes. By supplying multiple buildings, they avoid the need for individual boilers or electric heaters in every building.
DNO	Distribution Network Operators – the operator of the electric power/gas distribution system which delivers electricity/gas to most end users
EJM	Environmental Justice Measure is a framework created by Westminster council aimed to highlight inequalities in how people are impacted by/ impact climate change, and measure success against their 'Net Zero 2040' goals.
Energy flexibility	Energy flexibility is the ability to adjust generation and demand to achieve energy balance and to support the electricity network.
EPC	Energy Performance Certificate – provides an indication of a building's energy efficiency
EV	Electric Vehicle
EWI	External Wall Insulation
FES	Future Energy Scenarios are produced by National Grid to examine different decarbonisation pathways at a national scale
FES	Future Energy Scenarios -provide a set of scenario projections for Great Britain and focuses on the whole energy system considering how the energy system can be decarbonised
Flexibility Services	It is where a DNO pays owner of generation assets or low carbon technologies, such as wind turbines, battery storages, solar panels, and electric vehicles to turn down/up their assets for an agreed period. This is done to free up capacity in the network, allowing it to be utilized elsewhere for balancing purposes.
FPEER	Fuel Poverty Energy Efficiency Rating – It Is the methodology used by Department for Energy Security and Net Zero (DESNZ) for the purpose of producing fuel poverty estimates. It is derived from the Standard Assessment Procedure (SAP) rating for assessing energy performance of domestic properties but includes policy interventions that directly affect household energy costs.
GFF	GLA Green Finance Fund - an internally managed debt facility to support the capital investment of environmental projects from the GLA Group and other strategic partners across London.
GHNF	Green Heat Network Fund – it is a Capital grant support available for the development of new low and zero carbon heat networks and retrofitting and expansion of the existing heat networks
GLA	Greater London Authority
Green Book	The Green Book is guidance issued by HM Treasury on how to appraise policies, programmes and projects. It also provides guidance on the design and use of monitoring and evaluation before, during and after implementation.
HGV	Heavy goods vehicles
HNDU	Heat Network Delivery Unit – It provides grant funding and guidance to local authorities in England and Wales for heat network project development
HNES	Heat Network Efficiency Scheme – It provides funding to public, private and third sector applicants in England and Wales to support improvements to existing district heating or communal heating projects that are operating sub-optimally and resulting in poor outcomes for customers and operators.
ICEs	Internal Combustion Engines
IMD	Indices of Multiple Deprivation
IWI	Internal Wall Insulation
LAEP	Local Area Energy Planning – It is a data-driven process which provides a pathway to decarbonise energy system entirely in an area in a given time frame
LCSF	Low Carbon Skills Fund
LEVI	Local Electrical Vehicle Infrastructure fund
LGV	lights goods vehicles
LSOA	Lower Super Output Areas
MEEF	Mayors Energy Efficiency Fund – It is a £500m investment fund which supports projects that deliver low carbon technology or upgrade existing infrastructure to help achieve Mayor's ambition to make London net zero by 2030
MSOA	Middle Super Output Areas
NIA	Network Innovation Allowance
NZN	Net Zero Neighbourhoods - work with local authorities and communities to find new ways of renovating and retrofitting homes for a low carbon future.
OFGEM	The Office of Gas and Electricity Markets
OFZEV	The Office of Zero Emissions Vehicle
OPEX	Operational expenditure – provides an indication of running costs. This often includes fuel and carbon in the LAEP context
PDHU	Pimlico District Heating Undertaking
PSDS	Public Sector Decarbonisation Scheme
PV	Photovoltaic
REPD	Renewable Energy Planning Database
SIF	Strategic Innovation Fund
UKIB	UK Infrastructure Bank -It is a government-owned policy providing infrastructure finance and partnering with the private sector and local government to finance a green industrial revolution and drive growth across the country
UKPN	UK Power Networks - UK Power Networks is a distribution network operator for electricity covering Southeast England, the East of England and London.
Waste Heat	The unused heat that occurs in mechanical and thermal processes
WCC	Westminster City Council

Executive Summary

Overview

Westminster City Council (WCC) declared a climate emergency in 2019, aiming to be a net zero council by 2030 and net zero city by 2040. An action in the 2021 Climate Emergency Action Plan was to undertake 'a feasibility assessment of clean and renewable energy opportunities across Westminster to inform a Local Area Energy Plan, enabling local low carbon energy expansion.'

This Local Area Energy Plan (LAEP) technical report provides pathways for decarbonisation of the energy system in Westminster. This is a technically led report developed by Buro Happold in conjunction with WCC. The council will be engaging internally and with interested stakeholders to determine the next steps upon publication of the report.

Scenarios tested and stakeholder engagement

Following initial modelling of four core scenarios, a combined LAEP scenario was selected for detailed modelling (Table 0—1).

Table 0—1 Summary of strategy for the Final LAEP scenario.

Fabric improvement	Focus on windows (loft and cavity if appropriate). Aim to create 40% heat demand reduction, coupling fabric and behaviour change.
Heat networks	Minimum ~46% of buildings connected based on scenario. Short time frames promote technology – 73 MWh/yr demands connected if in zones.
Heat pumps	High uptake in non-flat domestic properties. Communal heat pump solutions also see high uptake in flats and other properties which contain multiple properties.
Car ownership reduction	Modal shift in car ownership and use, 27% reduction in miles by 2030. Reflected in 27% drop in ownership.
EV charger numbers	4.5 chargers per space with 20% coverage in car parks.
Renewable deployment	90 MW – 50% increase of GLA target. Equivalent of ~6% of roof space.
Flexibility / diversity	High levels of peak shaving and high diversity. Heat pump diversities align to standard commonly used for DH.

Intervention areas considered

Detailed interventions are presented within each section of the main report with an overview and priority interventions highlighted here and summarised in Table 0—2.

Fabric

Westminster is a London Borough rich in heritage and history with a significant proportion of properties constructed pre-1919 using traditional solid-wall construction methods. This is reflected in a high rate of single glazing and poor fabric efficiency, which contributes to more than 60% of all the city's building stock having an Energy Performance Certificate (EPC) of D or lower. Adding further complexity is the fact that an estimated 76.6% of Westminster's properties are within a conservation area and that over 4,000 buildings and a further 7,000 structures are listed. Minimum fabric improvements are therefore required to introduce low carbon heating system efficiently which has a high cost to the delivery plan.

Heat

Westminster's gas demand is the 16th highest in the UK and the largest in London, this dependency on gas highlights the challenge of switching towards electrified heating solution. The non-domestic demand presents the largest share with largest distribution of demand concentrated in the West End area. Due to various constraints the buildings in this area of the gas network are going to be some of the most challenging to switch to low carbon solutions.

Overall, heat networks and communal heating systems will be the dominant route to decarbonisation – with heat provided typically via electrified heat pump technology. In current draft central government zoning proposals for Westminster, the majority of the borough is flagged as a heat network zone (which means that buildings of a certain scale may be mandated to connect to a heat network). However, there are a number of smaller properties (up to around 10% across both domestic and non-domestic stock) which are best placed for individual solutions, most likely using local heat pumps to deliver heat.

Local Power generation

Due to Westminster's dense urban environment and vast coverage of protected areas, renewable development is limited with rooftop solar photovoltaics (PV) deemed the only suitable technology to be deployable at scale within the borough. The large proportion of conservation areas, listed buildings and other heritage statuses creates some challenges for implementation and therefore the LAEP proposes an adopted solar PV target of 90 MW.

Approximately 20% of priority opportunities for solar are on properties within WCC control. The early installation of rooftop solar PV is recommended to provide highest impact on carbon emissions, as grid electricity is decarbonising over time.

Transport

Transport, especially public transport is key to Westminster. Westminster houses 32 tube stations, three Elizabeth Line stations, and 73-day bus routes. It also includes Victoria train station, the second busiest in the UK. This public transport is a key enabler for decarbonisation, reducing reliance on personal vehicles. However, the LAEP focuses on locally based transport, covering cars, lights goods vehicles (LGVs), buses, coaches, and heavy goods vehicles (HGVs). This is because it cannot be expected for the LAEP area to offset national transport emissions of vehicles travelling through.

By 2040, 98% of cars will be EVs which is substantially a higher proportion than that of the current 14%. The transitional shift to EV uptake will result in a substantial requirement for charging infrastructure at a household/street/car park level (roughly triple the capacity with current EV charging capacity within Westminster). This will impact existing electricity infrastructure and current headroom. In addition, 'Transport Hubs' (including hospitals, police stations, coach stations) will likely require grid reinforcement to the power infrastructure supplying these sites, due to the high average EV charger capacity requirement at each site.

Energy Infrastructure

There are two main elements of additional infrastructure requirements for the LAEP. The first is deployment of heat networks, which in the LAEP scenario provide heat to 69,000 properties and the majority of Westminster's heat demand.

Alongside heat networks, substantial reinforcement of the electricity network is required. A small part of this is for the electrification of transport, however, the main element is the electrification of heat. These combine to increase electricity demand in Westminster by over 1,000 GWh/yr in the LAEP scenario, this is more than the current electricity demand for the average London borough. The cost of the reinforcement is modelled at £370 million, however, it carries a high level of uncertainty due to the lack of visibility of existing network infrastructure at the lower voltage levels available at the time of the study to carry out detailed modelling.

Table 0—2 Summary of key technology install and actions to achieve the LAEP scenario.

Item	Current status/context	Requirement 2027	Requirement 2030	Requirement 2035	Requirement 2040
Domestic fabric improvement	60000 single glazed properties, 12600 properties with uninsulated cavity walls, up to 29000 with insulated roofs and 104000 uninsulated solid walls (not a priority).	Retrofit a total of 12000 properties.	Retrofit a total of 37300 properties.	Retrofit up to 79700 properties.	Retrofit up to 87600 properties.
		5400 of which are on land in WCC ownership.	*12400 of which are on land in WCC ownership.*	*14600 of which are on land in WCC ownership.*	*14600 of which are on land in WCC ownership.*
Non-domestic fabric improvement	23000 single glazed properties, 1800 properties with uninsulated cavity walls and 32000 uninsulated solid walls (not a priority).	Retrofit a total of 2600 properties.	Retrofit a total of 8900 properties.	Retrofit up to 19000 properties.	Retrofit up to 21000 properties.
		220 of which are on land in WCC ownership.	*450 of which are on land in WCC ownership.*	*500 of which are on land in WCC ownership.*	*500 of which are on land in WCC ownership.*
Property level heat pumps	Currently 1800 domestic heat pumps in Westminster, data is not reliable to provide a non-domestic figure	Total of 2300 additional property level heat pumps installed.	Total of 8000 additional property level heat pumps installed.	Total of 11600 additional property level heat pumps installed.	Total of 16600 additional property level heat pumps installed.
		350 of which are on land in WCC ownership.	*1100 of which are on land in WCC ownership.*	*1100 of which are on land in WCC ownership.*	*1100 of which are on land in WCC ownership.*
Communal and district heat networks[1]	Two large district heat networks, 43 WCC operated communal gas boilers. With other small communal networks total of 33200 properties connected.	Total of 3800 additional properties connected to communal systems or heat networks.	Total of 14000 additional properties connected to communal systems or heat networks.	Total of 71000 additional properties connected to communal systems or heat networks.	Total of 131000 additional properties connected to communal systems or heat networks.
		1400 of which are on land in WCC ownership.	*3900 of which are on land in WCC ownership.*	*8700 of which are on land in WCC ownership.*	*8700 of which are on land in WCC ownership.*
Electric vehicle infrastructure	2500 EV charge points currently installed.	Install an additional 1500 EV charge points.	Total of 2800 additional EV charge points.	Total of 6700 additional EV charge points.	Total of 10050 additional EV charge points.
Solar PV installation	2 MW of current PV capacity	21 MW of additional PV capacity.	44 MW of total additional PV capacity installed.	76 MW of total additional PV capacity installed.	89.5 MW of total additional PV capacity installed.
		5 MW of which is on land in WCC ownership.	*9 MW is on land in WCC ownership.*	*16 MW is on land in WCC ownership.*	*23 MW is on land in WCC ownership.*

[1] There is a high degree of sensitivity in the relationship between communal and district heat networks. This includes some communal networks connecting to wider heat networks, uncertainty in data cataloguing for current systems, the varying scale in heat networks identified and the marginal cost difference between communal and heat networks in the model outputs.

Overview map of priority interventions

As part of the report, several precisely located projects have been identified as low regrets and/or achievable in the near term. As well as existing projects such as the South Westminster Area Network, NW8 network development and South Kensington Heat Network, a number of 'low regrets' projects which significant emissions reduction potential were identified. A long list of interventions is included within the main report with the shortlisted priority projects presented in Figure 0—1.

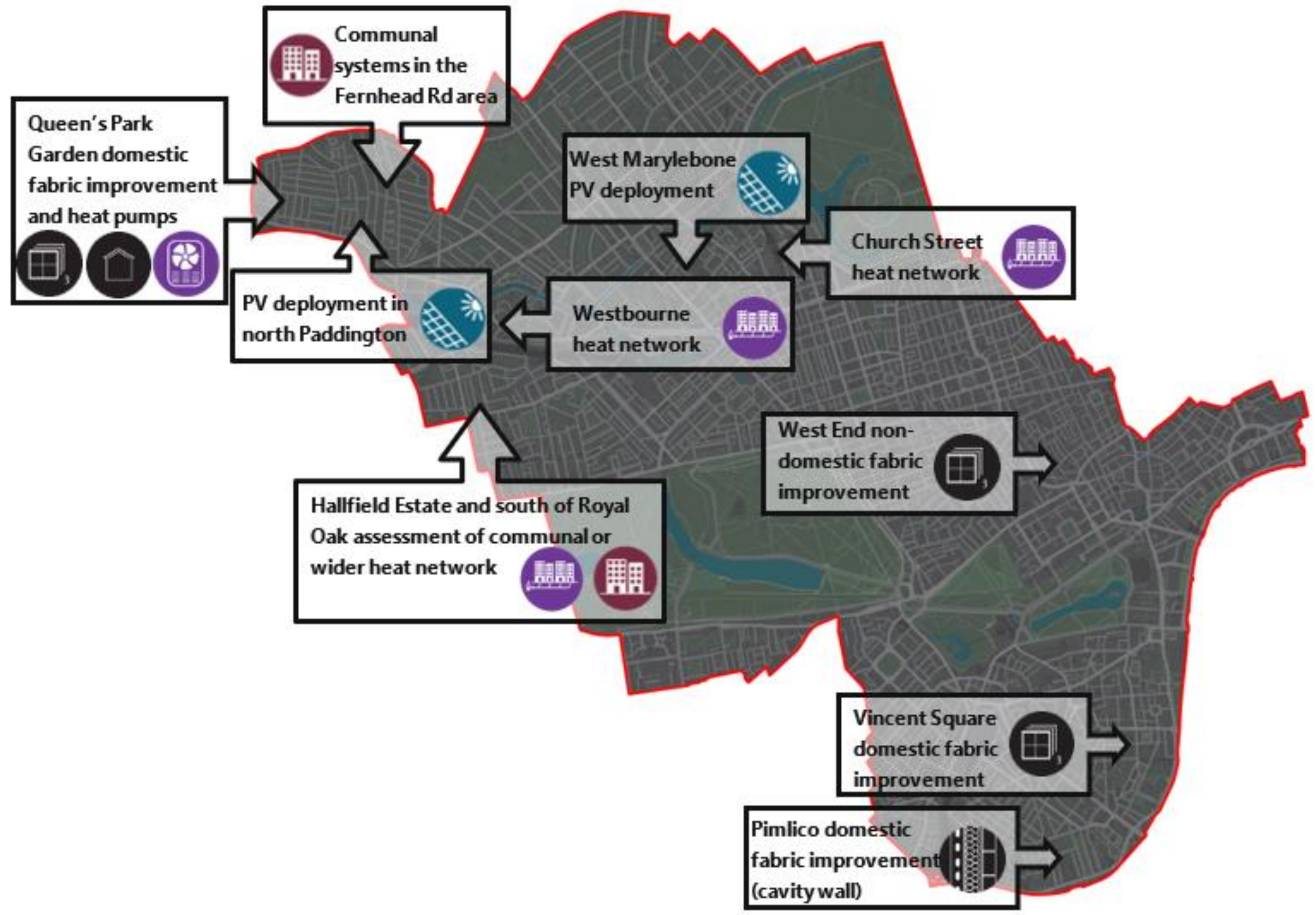


Figure 0—1 Shortlisted priority projects in Westminster

Carbon trajectory

The primary aim of the Local Area Energy plan is to create an energy system trajectory which reduces emissions to reach net zero by 2040. A summary of the emissions reduction pathway for the LAEP Scenario compared to the Baseline is provided in Figure 0—2.

The pathways appear relatively similar for the LAEP Scenario and Baseline in the early years, this is primarily due to the similar pathways for transport and the decarbonisation of the electricity grid. After 2030 is when the pathways start to differentiate more, due to the electrification of heating in the LAEP Scenario.

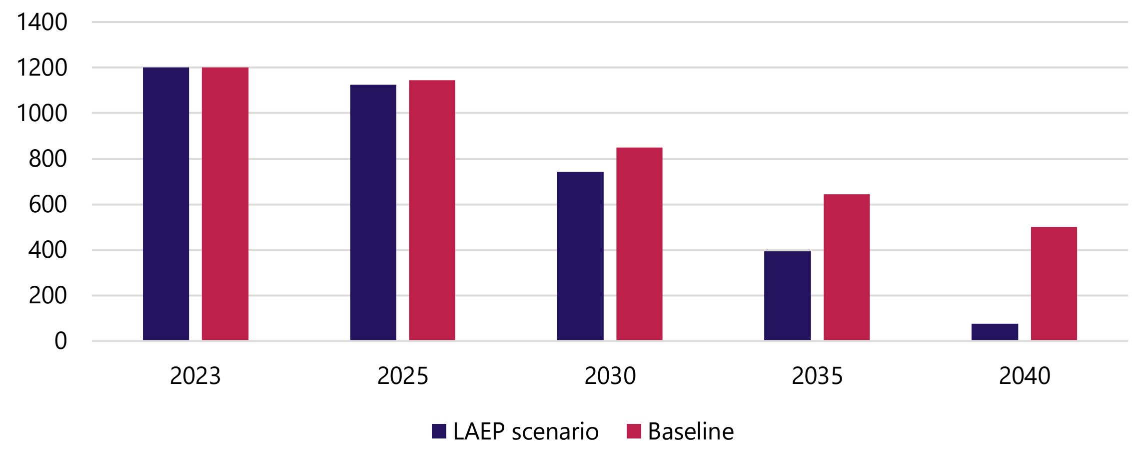


Figure 0—2 Carbon emissions based on primary energy consumption to 2040 for the LAEP scenario and Baseline.

Investment and operational costs

The LAEP Scenario for Westminster calls for a large amount of investment (over £5bn), however, it should be noted that even the Baseline scenario will also carry a financial burden (including replacement of existing heating systems). This is explored in Figure 0—3.

The scale of investment is perhaps unsurprising given that Westminster has the largest gas consumption in London and 4th highest per capita in the UK. With the nature of the existing building fabric and historic buildings the intervention cost is higher. The high heat density of Westminster, which generally makes a low carbon energy transition more cost effective, is somewhat mitigated by the very high costs associated with installing infrastructure in the area.

There is a large amount of sensitivity with the capital costs and a building-by-building assessment and detailed feasibility would be required to understand true costs. Some elements, for example secondary glazing being installed when glazing replacements are due, could also potentially be considered to be part of the baseline, which would significantly reduce the difference between the total capital expenditures.

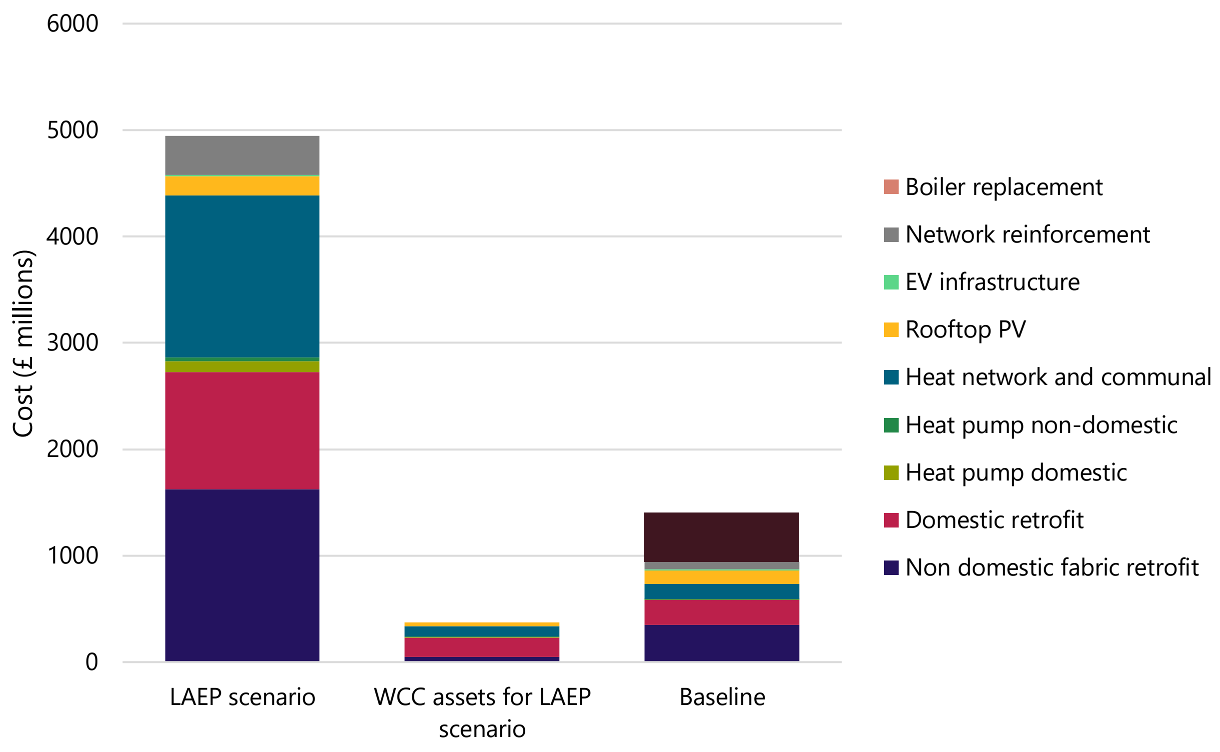


Figure 0—3 Capital investment to 2040 for the final LAEP scenario and the Baseline.

Whilst the capital investment is high much of this will not come from Westminster residents or the City Council, for example, much of the non-domestic fabric improvement and heat networks are likely to come from other investment sources, whilst electricity reinforcement is a socialised cost in most instances. The investment in the energy system does result in savings in operational costs. An overview of the different operational costs, based on fuel and carbon, for the LAEP Scenario and Baseline are provided in Figure 0—4.

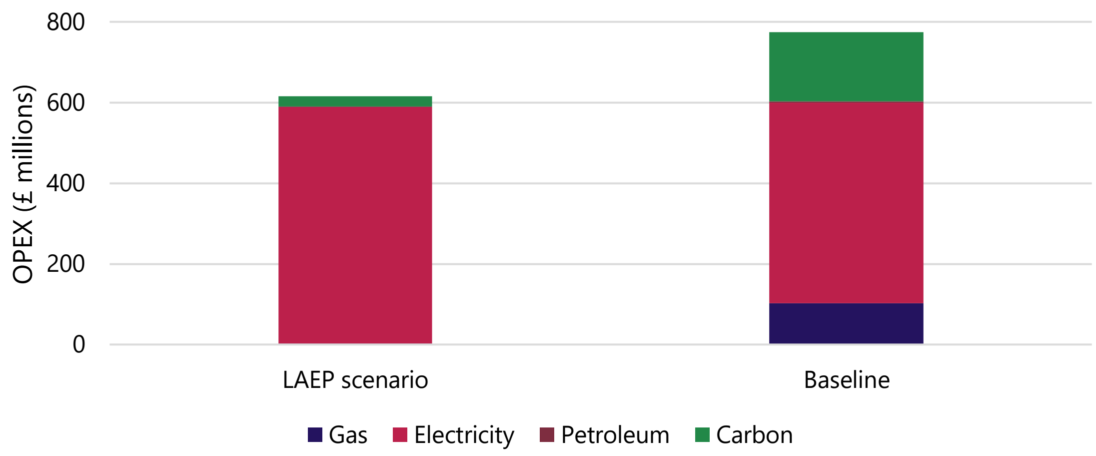


Figure 0—4 Operational fuel and carbon costs[2] for the LAEP scenario in 2040 compared to the Baseline.

[2] All costs are based on Green Book central scenarios for retail energy prices and carbon costs.

There are some marginal savings (£13 million) identified per year based on fuel costs in the LAEP scenario. This is relatively low as, even though the LAEP Scenario is far more efficient, the price of commercial electricity is ~3.4 times that of gas[3]. For contrast in the high fuel cost scenario in the Green Book the price of commercial electricity is only double the price of gas in 2040 – making the fuel-based saving more substantial (~£85 million). As the grid is decarbonising, the Government is considering whether there is a case for moving a range of social and environmental policies that seek to encourage low carbon power generation, currently applied to electricity bills, to gas bills or another form of taxation instead, in order to make the electrification of heat more attractive; if realised this may have a further positive impact sooner in the operational costs of the LAEP scenario [4].

Even with the high fuel cost it is carbon pricing, which is the most important factor between scenario costings, the LAEP Scenario has a modelled spend of £26 million on carbon in 2040 compared to £172 million for the Baseline. The majority of the remaining carbon in the LAEP scenario is from a not fully decarbonised grid. Carbon price increases over time whilst the electricity grid carbon factor decreases, as well as technology deployment these factors contribute to the greatest being seen towards the end of the LAEP modelling period. A higher carbon price could help the business case for the non-domestic properties within Westminster to decarbonise.

Co-benefits and Economic analysis

During the development of this Local Area Energy Plan, Westminster City Council partnered with London School of Economics' just transition climate finance lab on a research project focused on green finance and place-based climate investment. Through the development of this project, the Local Area Energy Plan pathway was analysed, and WCC and LSE partnered with University of Edinburgh to analyse the Local Area Energy Pathway, through an economic and co-benefits lens, over a time period of 2025-2050. The findings were:

<u>Co-benefits:</u>

- The total scale of the co-benefits across all interventions proposed in Westminster equates to £171 million over the study period 2025 – 2050, with an annual average of £7 million. Over the study period, the per capita co-benefits are estimated at £675 across the local authority.

- Improvements in air quality comprise over half (52%) of all co-benefits, with reduced excess cold over a quarter (26%) and dampness reduction (15%) and noise (6%) making up the remaining co-benefits.

- Priority zones identified in the LAEP by Westminster's Environmental Justice Measure are responsible for 14% of total Westminster co-benefits measured, yielding social value estimates of £23.21 million.

- The expansion of heat networks and communal heat pumps was the most significant contributor to overall co-benefits, representing 42%. Solar PV deployment contributed 26%, fabric improvements 17%, the switch to electric vehicles 9% and heat pumps contributed 6%.

- Comparing with capital costs of the interventions (without predetermining from where that cost is met), the co-benefits generated from Westminster-wide deployments equate to 3% and the Priority Zones deployment marginally higher at 6% of capex.

<u>Jobs and GVA:</u>

- The deployment of Westminster's low-carbon interventions could create a total of 177,274 direct, indirect and induced jobs across the UK.

- Of these jobs, 48016 would be direct, local jobs – lasting an average of 20 years each.

- The weighted median regional salary for these jobs is projected to be £44,843, which is 26% higher than the London median wage.

- The estimated direct and indirect GVA from all interventions in Westminster is £1.3 billion, which equates to an increase of 32% of value (compared to investment) to be spent within the UK.

This analysis demonstrates the economic value which could be attained through development of infrastructure set out in the Local Area Energy Plan.

Next steps – overall intervention plan

Through the development of this net zero pathway, a list of recommended short- and long-term actions has been presented to the Council, the key short-term recommendations for the council are:

- To focus on priority projects in the early years with a particular emphasis on local authority/housing association properties and public sector non-domestic buildings in the early years, this is both for heat pumps / heat network connection, solar PV installation and fabric improvements.
- Certain aspects of transport such as on street chargers and car parks are under greater public sector influence and can be (and are being) progressed early. Continue to roll out EV chargers and engage external stakeholders to enable transport hubs.
- Pursuing funding to realise pilot projects highlighted throughout the LAEP, notably various frameworks for supporting heat network deployment and promoting energy flexibility and diversity.
- Trialling delivery approaches to identified challenges within the technical report through the North Paddington programme.
- To continue working with research partners and external stakeholders to explore innovative green finance mechanisms to attract investment in the identified technologies within the chosen energy scenario.
- Engage with UK Power Networks on key areas for electricity infrastructure upgrades to enable the transition as well as exploring flexibility opportunities to keep these upgrades to a minimum.
- Engage and support national government in the development of existing Heat Network projects, including SWAN and the Advanced Zoning Pilot.

[3] Commercial prices are used as they are more suitable for communal systems and heat networks that will provide the majority of heating system capacity.

[4] Balancing act (ctfassets.net)

Introduction

Introduction

This document provides a Local Area Energy Plan technical report for Westminster. This is a technically led report developed by Buro Happold in conjunction with WCC. The next steps will be for WCC to decide on how to use the findings of the LAEP in the context of broader strategy, policy, and actions. The focus is within the boundary of the borough (as highlighted in Figure 0—1) but does include consideration of a wider London context, from both a policy and energy system perspective.

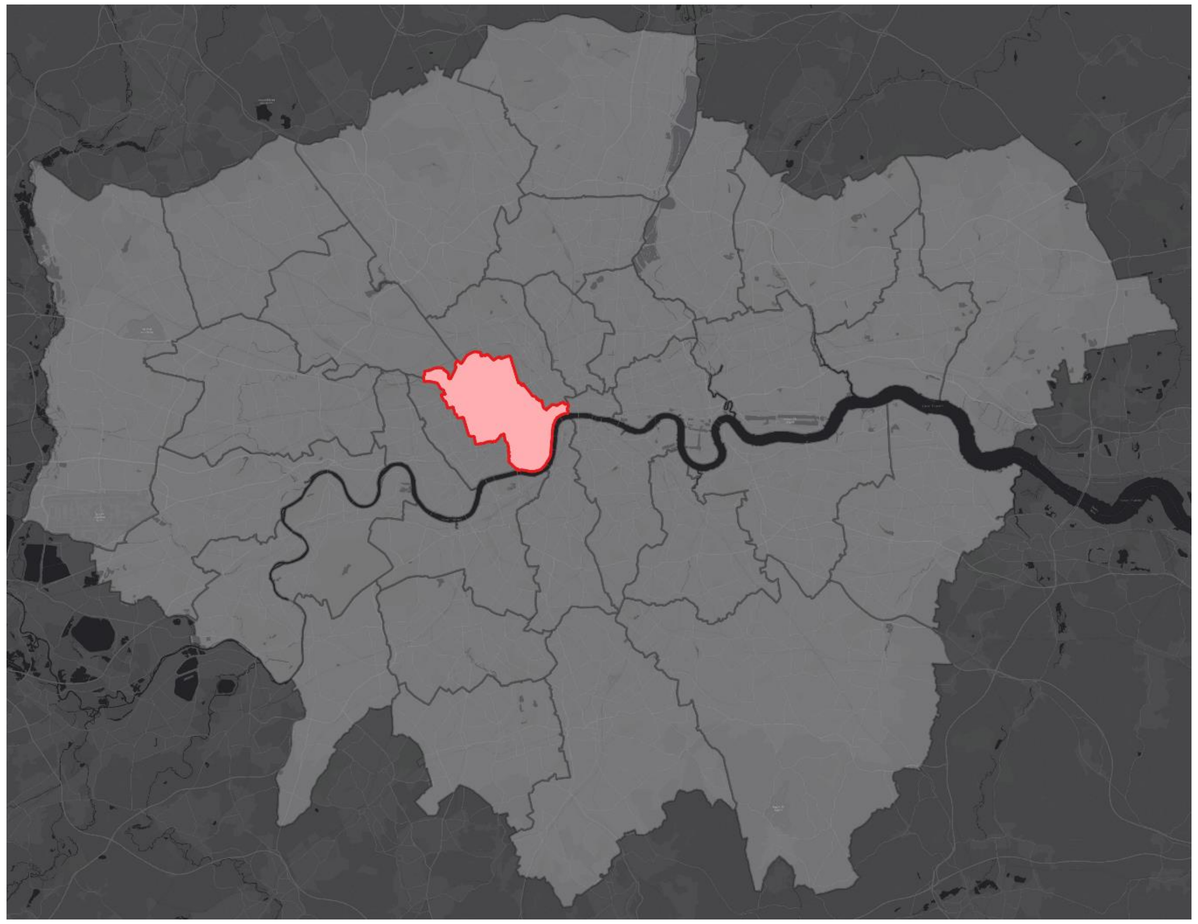


Figure 0—1 Westminster in context of all London Boroughs

Local Area Energy Planning is a process which has the potential to inform, shape and enable key aspects of the energy system transition[5]. Key to this is understanding the specific characteristics of the local area and how this translates into different pathways for a net zero energy system. Net zero is taken to mean all emissions are equal to or less than the emissions removed from the atmosphere in the area examined.

The LAEP looks across all energy system vectors at multiple scales from building level to beyond a local authority boundary, this is illustrated in Figure 0—2.

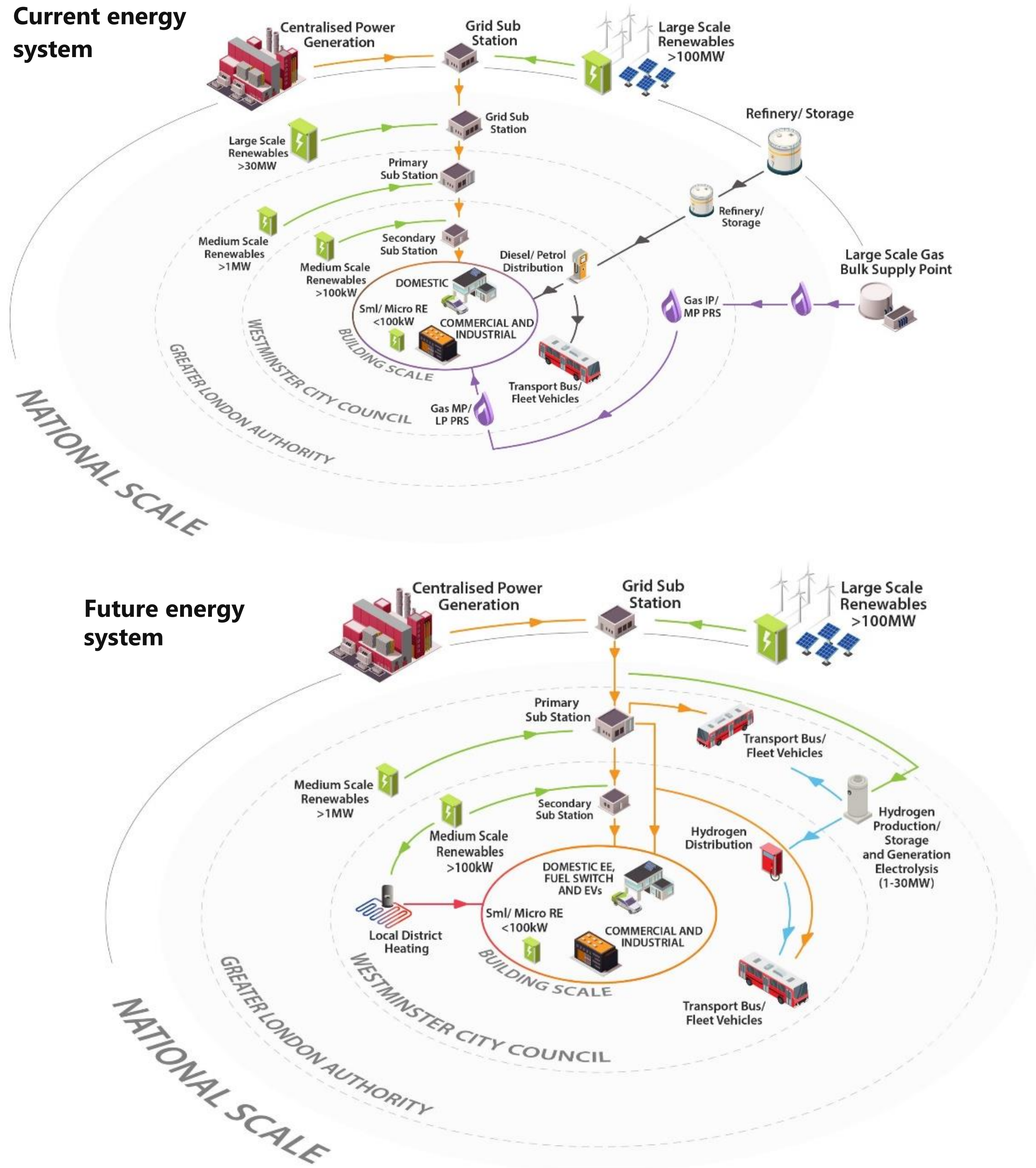


Figure 0—2 Simplified overview of potential energy transition pathway identified in an LAEP.

5 https://es.catapult.org.uk/report/local-area-energy-planning-the-method/

LAEPs sit between the local authority influence and the national scale, striking the balance between wider national strategy and the precise local requirements. The energy system is likely to become more complex and interconnected as it transitions to net zero, meaning it is important to have a plan in place at a suitable scale to understand these complexities and implement this transition.

There are many different scenarios for reaching net zero, perhaps best characterised by the direction of travel for the decarbonisation of heat; with large scale electrification of heat or the switch from natural gas to hydrogen being key options considered nationally. The LAEP examines different pathways or scenarios for decarbonisation of all energy demand sectors, be it heat, transport or electricity to see which is most suitable for the local area. This takes into account geography, local policy and likelihood of deployment among other factors.

Across different scenarios for decarbonisation there are likely to be common technologies and themes, such as energy efficiency improvements. This LAEP identifies areas which present a good initial opportunity for such measures, creating low regrets actions which can be taken in the near term, as they represent low regrets opportunities (i.e., common solutions) across all scenarios.

Report structure

The structure of the report is set out as follows:

Westminster context – characterisation, policy review, stakeholders, non-technical baseline

Scenario definition – decarbonisation scenarios considered in development of the preferred pathway.

Review of energy systems – covering baseline knowledge of each system, outcomes of the preferred scenario modelling, priority projects to take forward.

- Domestic and non-domestic buildings
- Heating and cooling
- Local power generation
- Electricity Infrastructure needs including transport

Plan summary – roadmap of the plan, costs, emissions, and key next steps for development of the plan

Reporting scales

Much of the data we use for our analysis goes down to an individual building level. We can therefore provide data from the LAEP at all scales. For communication purposes in the report, it was agreed to present information as:

- Lower Super Output Area (LSOA) for overview of analysis
- 100m grid for more detailed views of outcomes
- Primary substation level for UKPN electrical infrastructure outputs
- Heat network zones and similar outputs are more precise as these are directly linked to particular buildings.

An illustration of these different scales of reporting is provided in Figure 0—3.

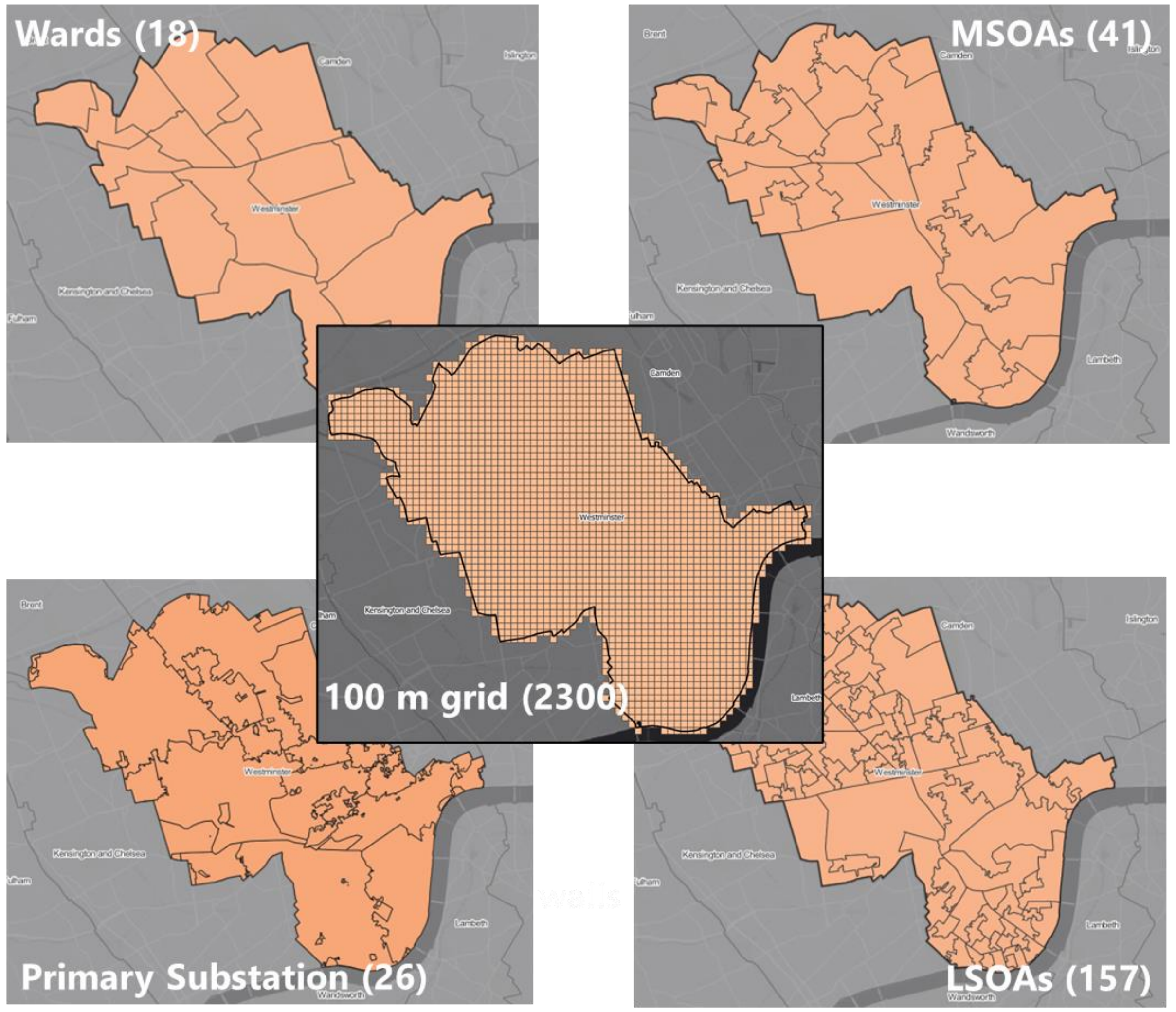


Figure 0—3 Potential reporting scales for the LAEP

Baseline

Westminster characterisation

Westminster is a small London borough by area of ~2,300 Ha (27th of 32 London boroughs), however is 11th in regard to population density, with a population of ~205,000 within the 2021 Census.

Business and tourism are two key subjects with the Borough, with over 52,000 businesses and 767,000 jobs. This is in part responsible for the large number of Business Improvement Districts (BIDS) in Westminster, displayed in Figure 0—1. With such a large number of businesses transport infrastructure is key for the large number of daily commuters as well as for the 25 million average yearly visitors, and 434,000 and 296,000 daily travel numbers for tourism and shopping respectively. The composition of Westminster's buildings are 78% domestic properties (~140,000) and 22% non-domestic properties (~37,500).

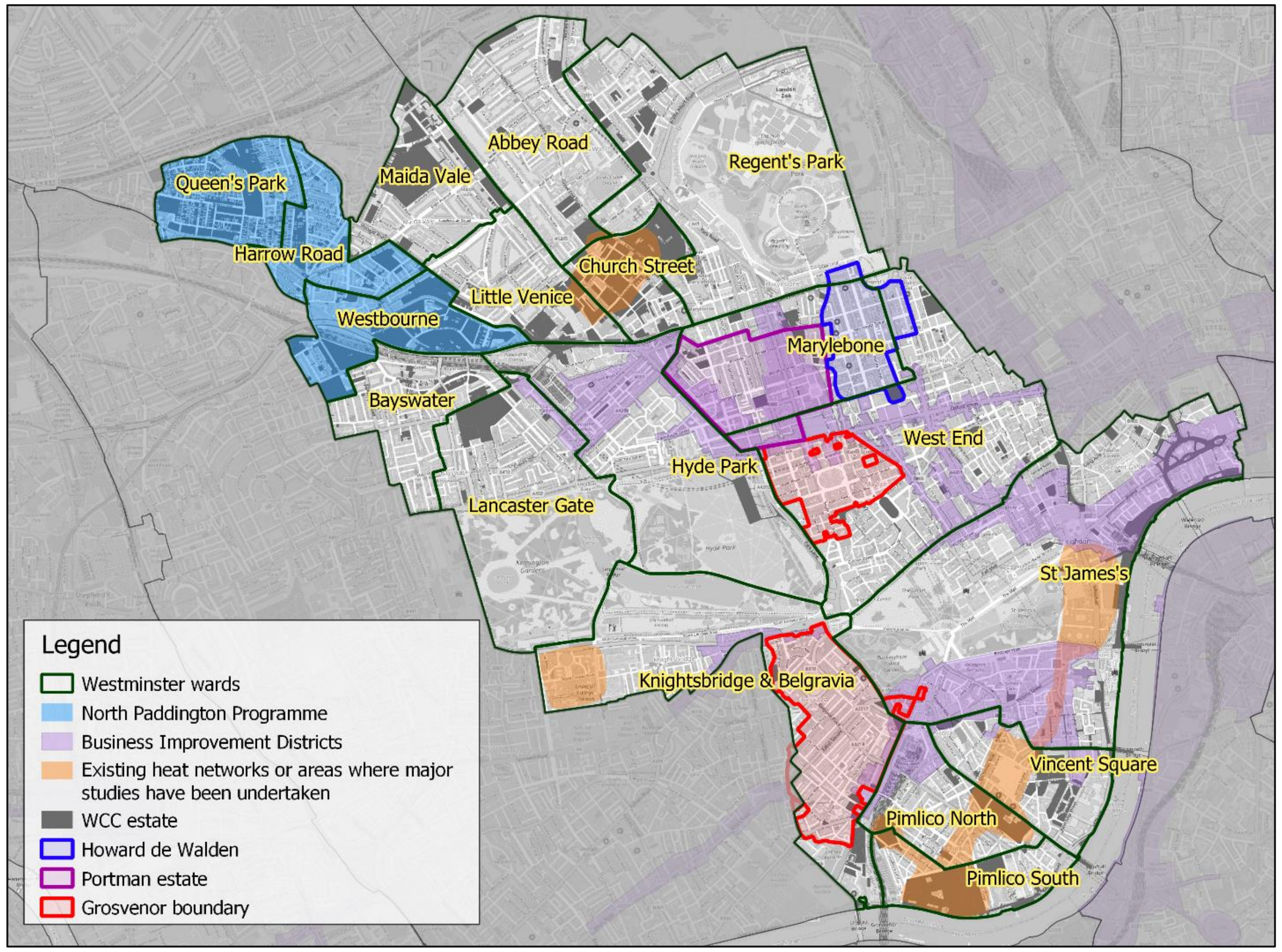


Figure 0—1 Overview of major projects, opportunities, and characteristics

Westminster is a London Borough rich in heritage and history various protected areas and great estates (three of which are highlighted in Figure 0—1). An estimated 70.5% of Westminster's properties are within a conservation area. Four key characterisations to Westminster are covered below, with these being prevalent within the study area are as follows, Green Space, Archaeological Priority Areas, Listed Buildings and Conservation Areas.

Green Space

The London Borough of Westminster has a large amount of green space for such a densely urbanised area, with almost one quarter of Westminster's 8.9 square mile area being open green space. With over 200 parks and open spaces across Westminster, these range from large royal parks to small ornamental gardens, squares and 'pocket parks'. The five Royal Parks that fall within Westminster accounts for around 80% of the total green space. Historic parks cover 23% of Westminster's total area which is the second highest percentage of all London Boroughs, second only to Richmond.

Whilst the historic nature of much of Westminster's green space will present some challenges it still present useful opportunities for a net zero pathway. Principally these opportunities are based around hosting infrastructure for the net zero pathways. Infrastructure could vary from ground source heat pumps and heat network pipes to locations for underground substations.

Listed Buildings and Structures

There are over 4,000 listed buildings in Westminster, with another 7,000 listed structures. Buildings are listed if they are considered to be of national architectural or historic interest. The London Borough of Westminster has the second highest concentration of listed buildings in London, with 475.4 listed buildings per sq. mile. These listed buildings will impact potential rooftop PV installations because, on top of typical planning permissions, a listed building consent (LBC) is also required for solar panels or any other works affecting its special architectural or historic interest.

The Historic Buildings and Monuments Commission lists buildings under three grades:

Grade I – 3.5% of Westminster's listed buildings = buildings of exceptional interest.

Grade II* - 88.6% of Westminster's listed buildings = particularly important buildings of more than special interest.

Grade II – 7.9% of Westminster's listed buildings = buildings that are of special interest.

Conservation Areas

Similarly, to green spaces and Archaeological Priority Areas, Conservation Areas also cover a significant area of Westminster. These protected areas are of notable environmental, architectural, or historical interest or importance, with 56 total conservation areas in Westminster. Westminster is the London Borough with the highest total percentage coverage at 76.6%, with Kensington and Chelsea is second (72.8%) and then Richmond Upon Thames is in third (52.7%), in comparison to England as a whole, 2.2% of England (2,938 square kilometres) is designated a conservation area. This high proportion of conservation area may impact the development of technologies due to potential constraints, such as insulation measures which are in keeping with character. The locations of Conservation Areas within Westminster is presented in Figure 0—2.

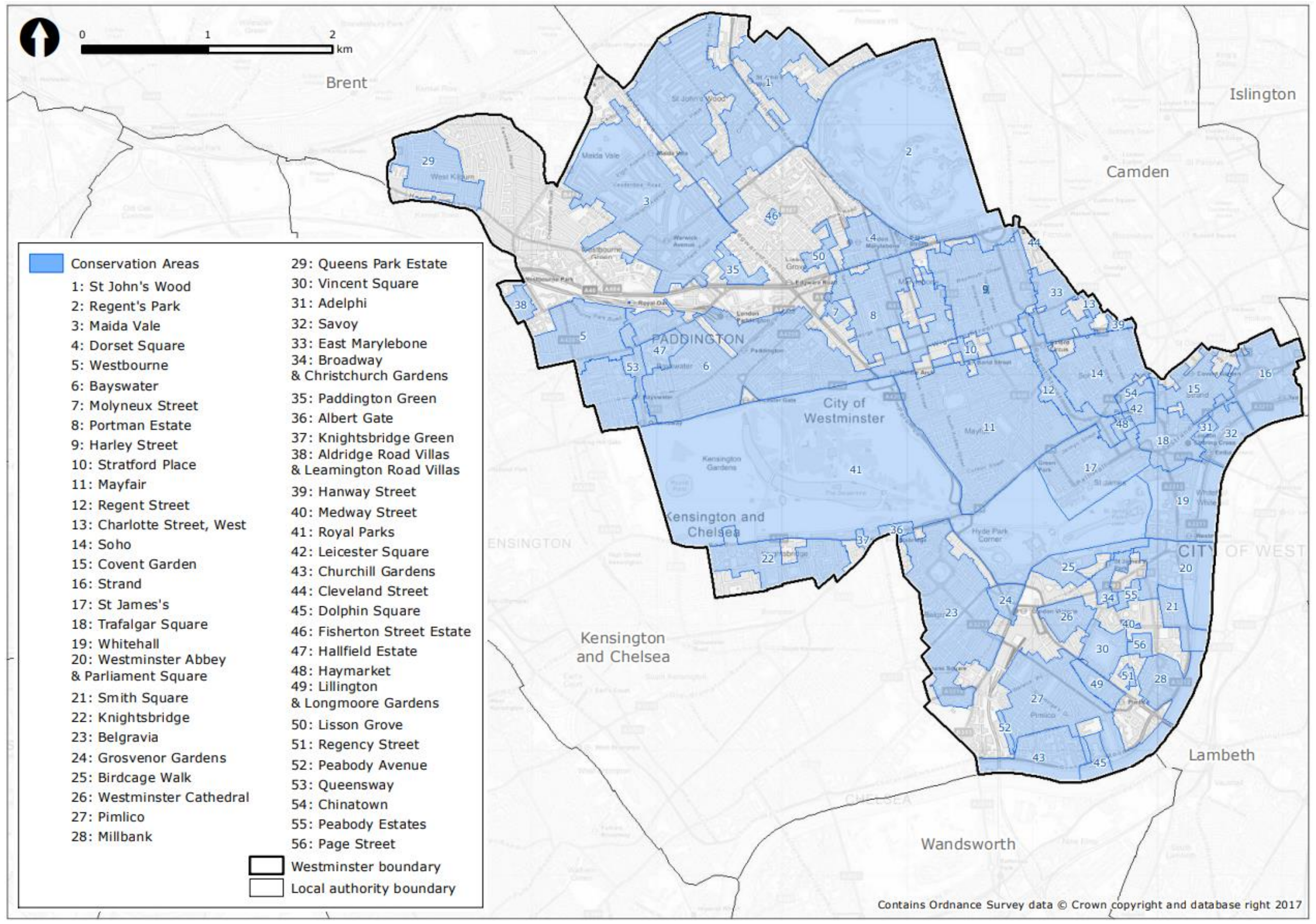


Figure 0—2 Conservation Areas within Westminster

Energy usage and building stock overview

Although the majority of properties (by count) are domestic buildings in Westminster, the largest Energy demand (Table 0—1) is associated with non-domestic properties due to their scale, age and usage.

Table 0—1 Westminster Energy Demands

Typology	No. properties	Heat demand GWh	Power demand GWh	Energy demand GWh
Domestic	140,086	1,293	411	1,704
Non-Domestic	37,554	3,349	3,346	6,695
Total	**177,640**	**4,642**	**3,757**	**8,399**

Domestic buildings

Westminster housing stock is relatively old with about more than half of these properties built pre-1900 or in the early 1900s as Figure 0—3 shows.

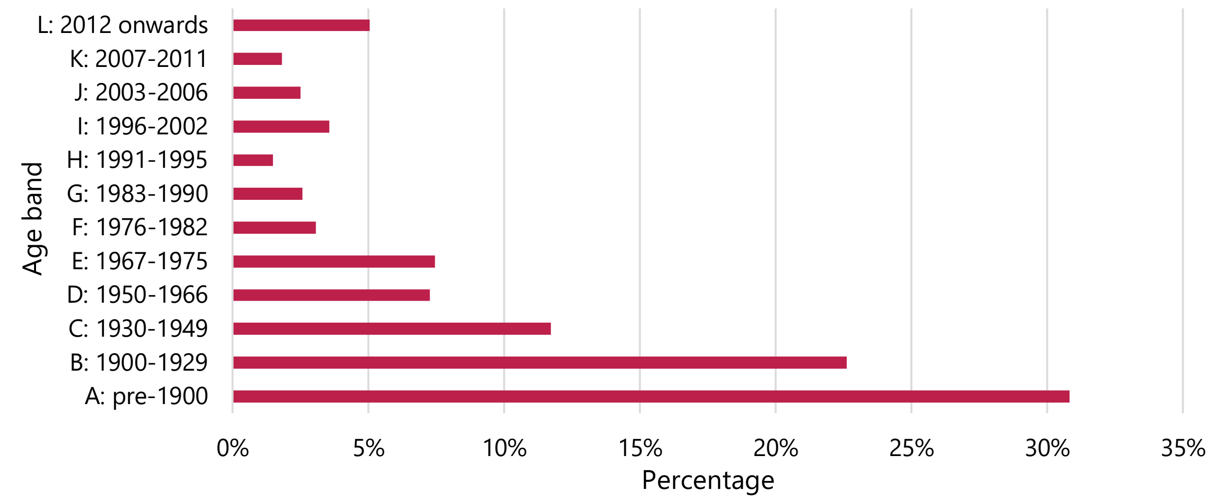


Figure 0—3 Age distribution among domestic properties in Westminster

Figure 0—4 provides statistics on the distribution of the domestic stock type and age in Westminster. Flats are the most dominant properties in Westminster, accounting for about 90% of stock.

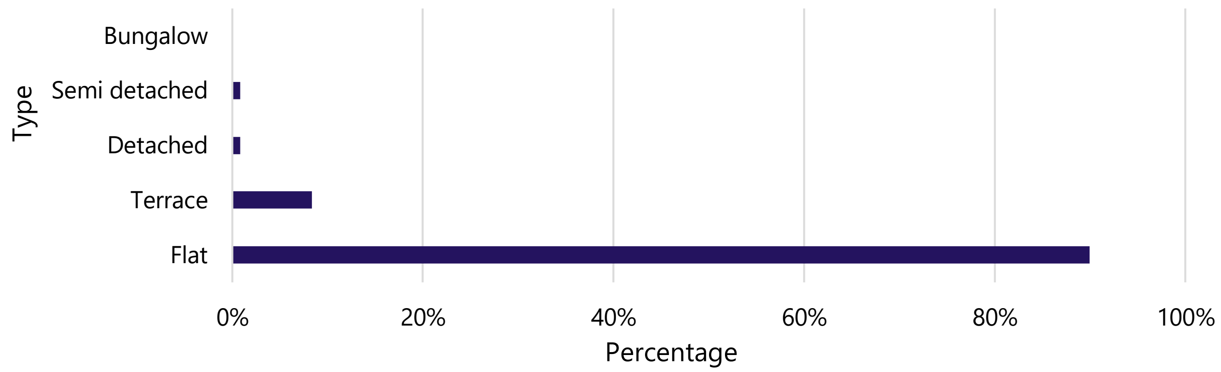


Figure 0—4 Domestic property type distribution in Westminster

The geographic distribution of these different domestic property types are shown in Figure 0—5. Notably, the majority of terrace and detached/semi detached properties are located in north west and north east of Westminster.

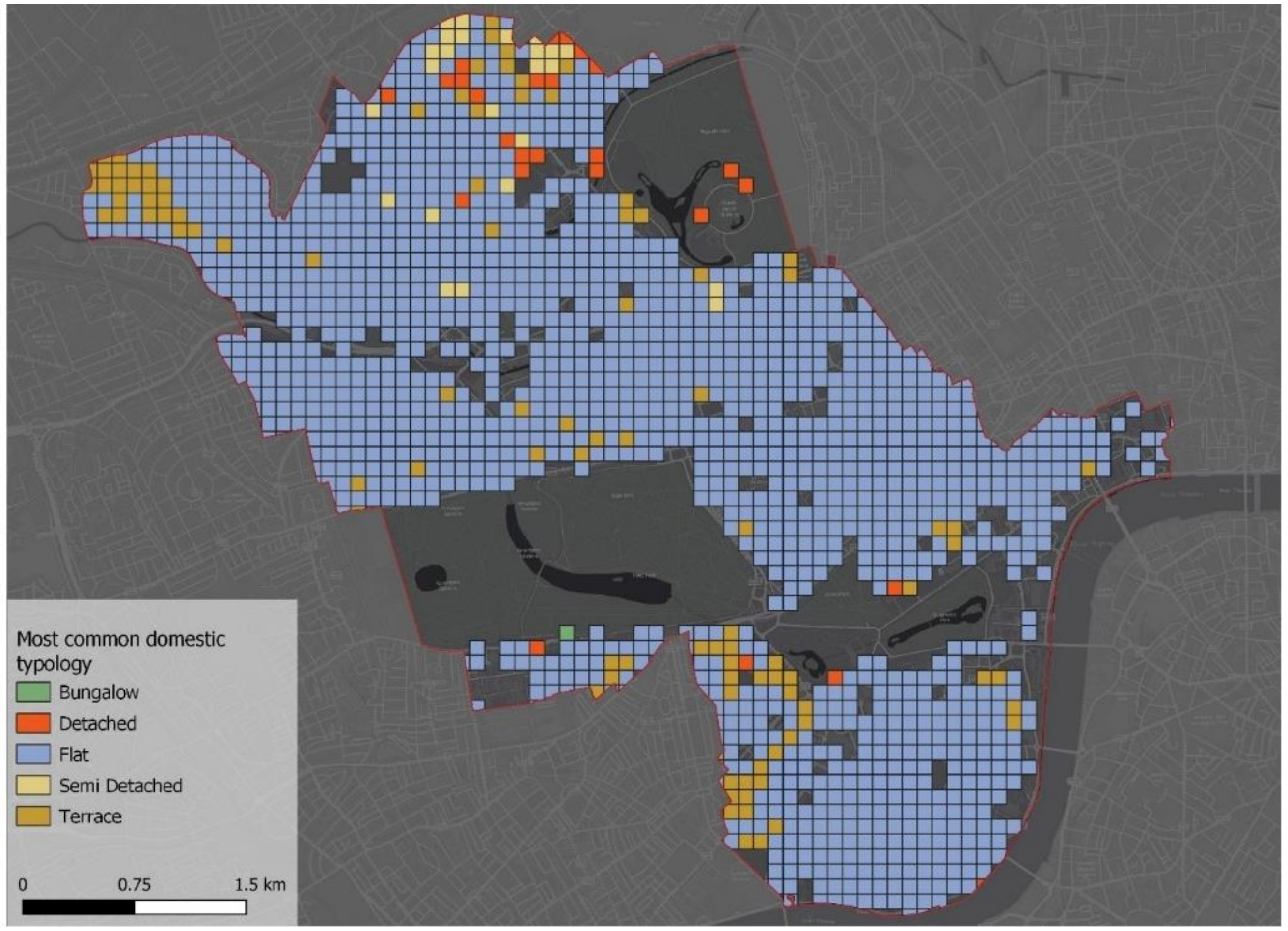


Figure 0—5 Most common domestic type at 100m grid scale

As well as domestic property type, the energy efficiency of these properties is key to the LAEP in determining the need an Figure 0—6 displays the distribution of Energy Performance Certificate (EPC) ratings among domestic stock in Westminster where above 60% of stock have EPC D and below.

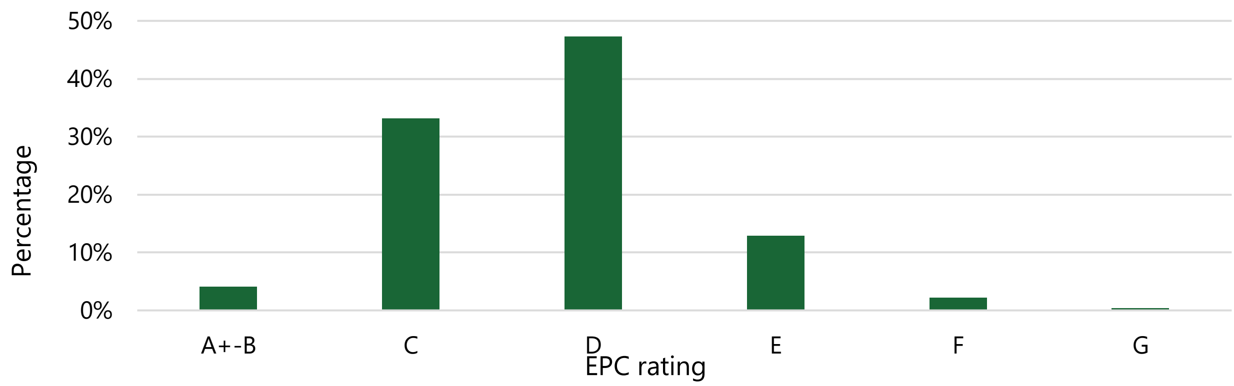


Figure 0—6 Share of energy efficiency performance ratings among domestic properties in Westminster

Given the age of properties and the very high quantity of single glazing and uninsulated walls in Westminster it is surprising that there are not more E-G properties. This shows there are potential issues when only considering EPC grades. However, they are useful in identifying initial areas to focus on.

Figure 0—7 shows the percentage of domestic properties with EPC ratings of D and below at the LSOA level which highlights the areas that requires greater attention for improving their energy efficiency and should be targeted first.

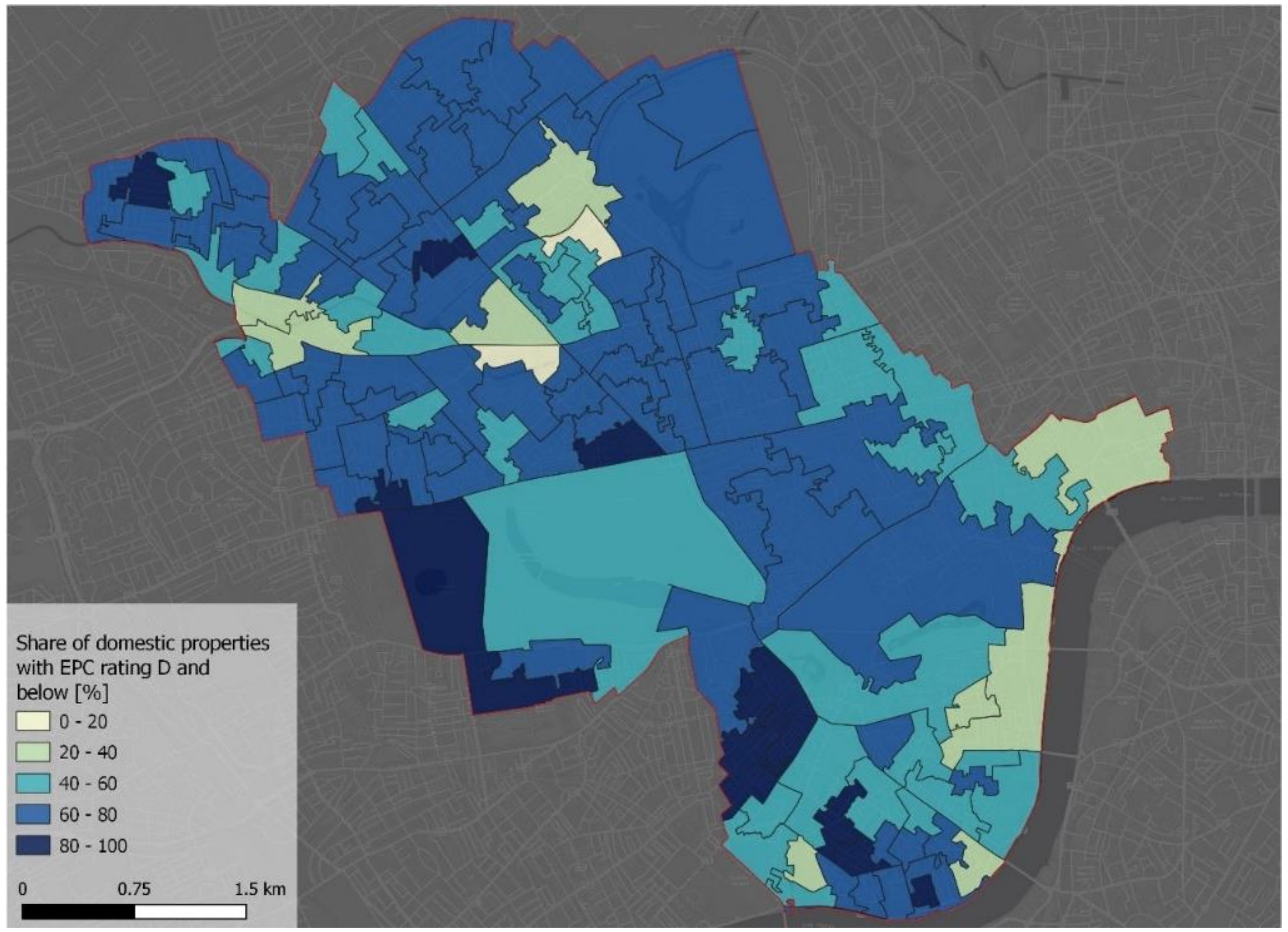


Figure 0—7 Percentage of domestic properties with EPC D and below on LSOA level

Non-domestic buildings

There are approximately 37,500 non-domestic properties in Westminster. Of these, above 55% are offices[6], with retail at 27% of the stock being the next most common typology. There are other high demand buildings including museums, theatres, and art galleries in Westminster, however, they constitute a small share of the building stock (209 count forming 0.6% of the total non-domestic property in Westminster).

More detailed information about the count and share of energy ratings among various non-domestic typologies can be found in Figure 0—8.

[6] This the equivalent to over 5% of all the offices in England and Wales.

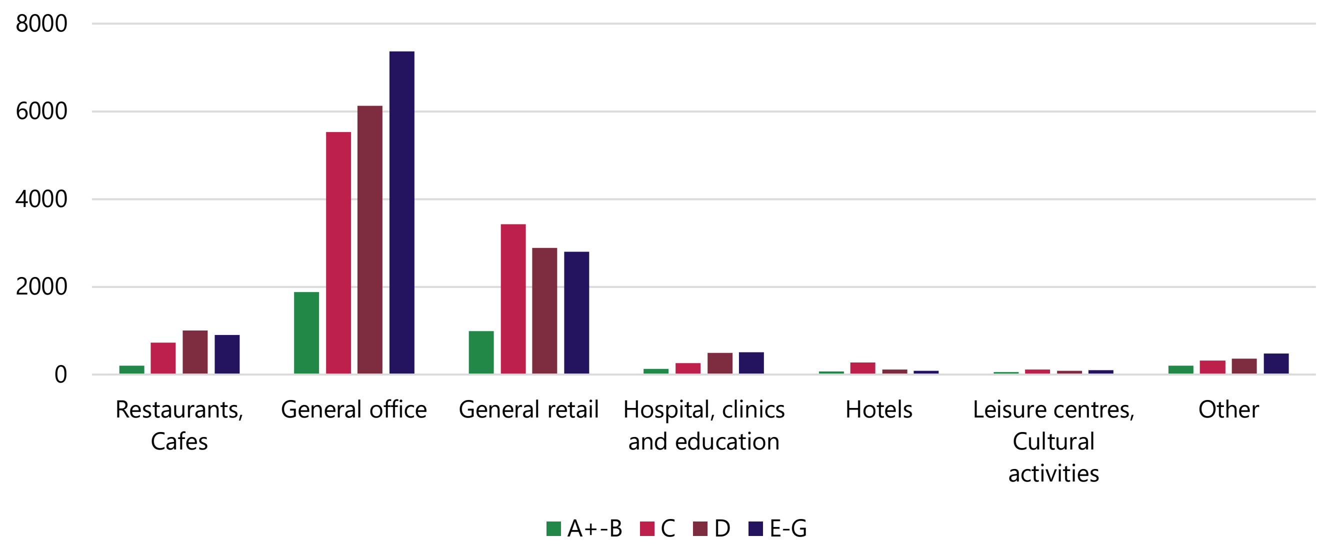


Figure 0—8 Count of of Energy ratings among different non-domestic typologies in Westminster

Among non-domestic typologies, hospitals, clinics, and education centre are among the lowest-performance buildings in Westminster, with more than 71% having an energy rating D or below. Whilst Hotels with above 60% having energy ratings above C are among the best performing non-domestic building typology.

Overall, as Figure 0—9 presents, more than 62% of non-domestic properties have energy rating D or below.

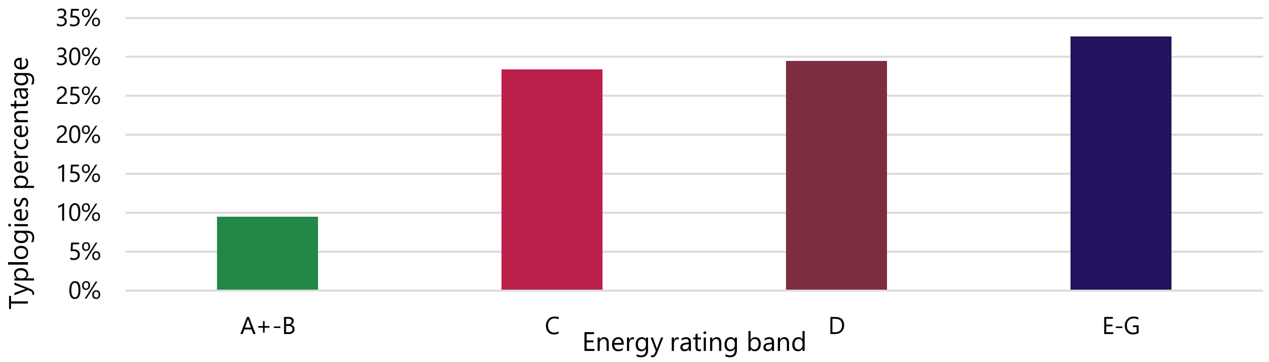


Figure 0—9 Share of energy efficiency performance ratings among non-domestic properties in Westminster

Future demands

Insights of future energy demands can be estimated based on planning applications sent to the Mayor of London and available on the "PlanApps" portal. This information is primarily based on major applications of strategic importance. 59 large planning applications from 2018 onwards were identified for modelling. The modelling estimated heat, power and cooling demands using standard industry benchmarks.

An area schedule for these planning applications is shown in Table 0—2 and following energy demands from these applications are outlined below within Table 0—3.

Table 0—2 Planning application area schedule

No. Applications	No. Residential Units	Commercial m²
59	6,772	796,203

Table 0—3 Planning application modelled energy demands

Heat Demand (GWh)	Heat Peak with diversification (MW)	Power Demand (GWh)	Power Peak with diversification (MW)	Cooling Demand GWh	Cooling Peak undiversified MW
63.1	61.8	64.8	57.7	32.0	55.1

The locations for the 59 Planning Applications are mapped in Figure 0—10, with each point being sized based on the benchmarked annual heat demand. The planning applications are clustered in three regions of Westminster: Paddington, Mayfair, and Victoria/Millbank.

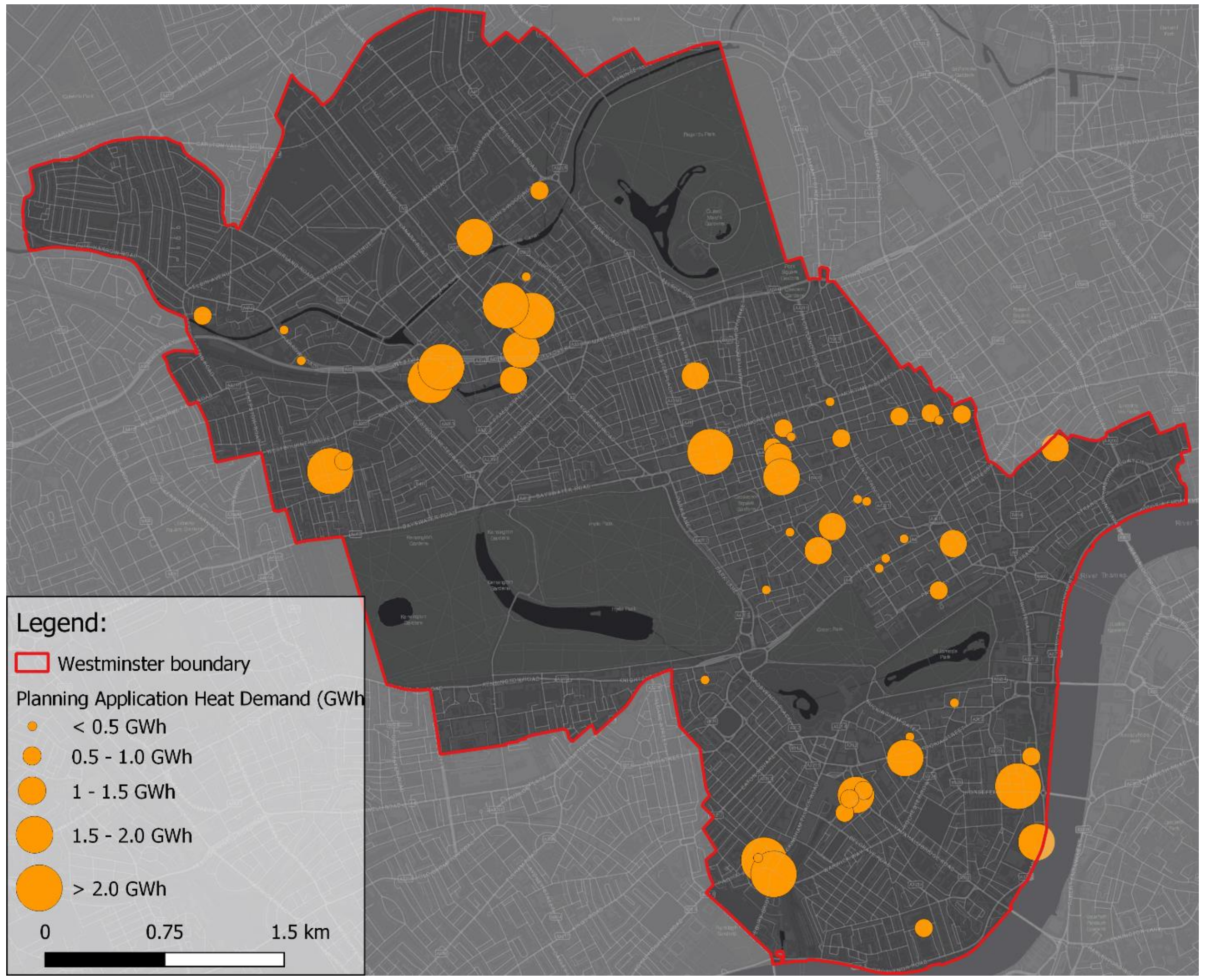


Figure 0—10 Map of planning applications sized by heat demand

Non-technical factors

Non-technical factors are important to an LAEP, as the transition to net zero should aim to be a just one - and as such must consider wider societal factors. These factors are considered through assessment of various matrices, including, Environmental Justice Measures, Fuel Poverty, and Indices of Multiple Deprivation (IMD).

Environmental Justice Measure (EJM)

The Environmental Justice Measure (EJM) is a framework created by Westminster council aimed to highlight inequalities in how people are impacted by the impact of climate change, and measure success against their 'Net Zero2040' goals. The council uses this to assist in identifying priority areas for environmental improvements, from retrofitting inefficient buildings to informing air quality monitoring and green space improvements. The Environmental Justice Measure (EJM) analysis covers a broad range of indicators, with 10 environmental indicators and one socio-economic indicator:

Environmental:

- Flood risk
- Heat risk
- Air quality
- Tree canopy cover
- Access to sustainable transport
    - Proximity to cycling facilities
    - Proximity to bus stops
    - % of people commuting by bike or walking
    - % of people commuting by public transport
- Proximity to public open spaces
- Average EPC (Energy Performance Certificate) rating

Socio-Economic:

- Index of Multiple Deprivation

The combined Environmental Justice Measure (EJM) score is made up of all 10 environmental metrics, weighted, and multiplied by the Index of Multiple Deprivation. This highlights the areas where the population may have particular barriers and are, therefore, disproportionally affected by climate change and poor environmental conditions. The ward that has the cumulative lowest score is Queen's Park, with the entirety of its area being scored 1. Church Street and Westbourne wards also seem to be scoring low overall, with the majority of their neighbourhoods being scored 1.

The EJM score by LSOA is given in Figure 0—11 and gives an overall picture of how different conditions and issues combine to create higher (darker) or lower (lighter) environmental impact overall.

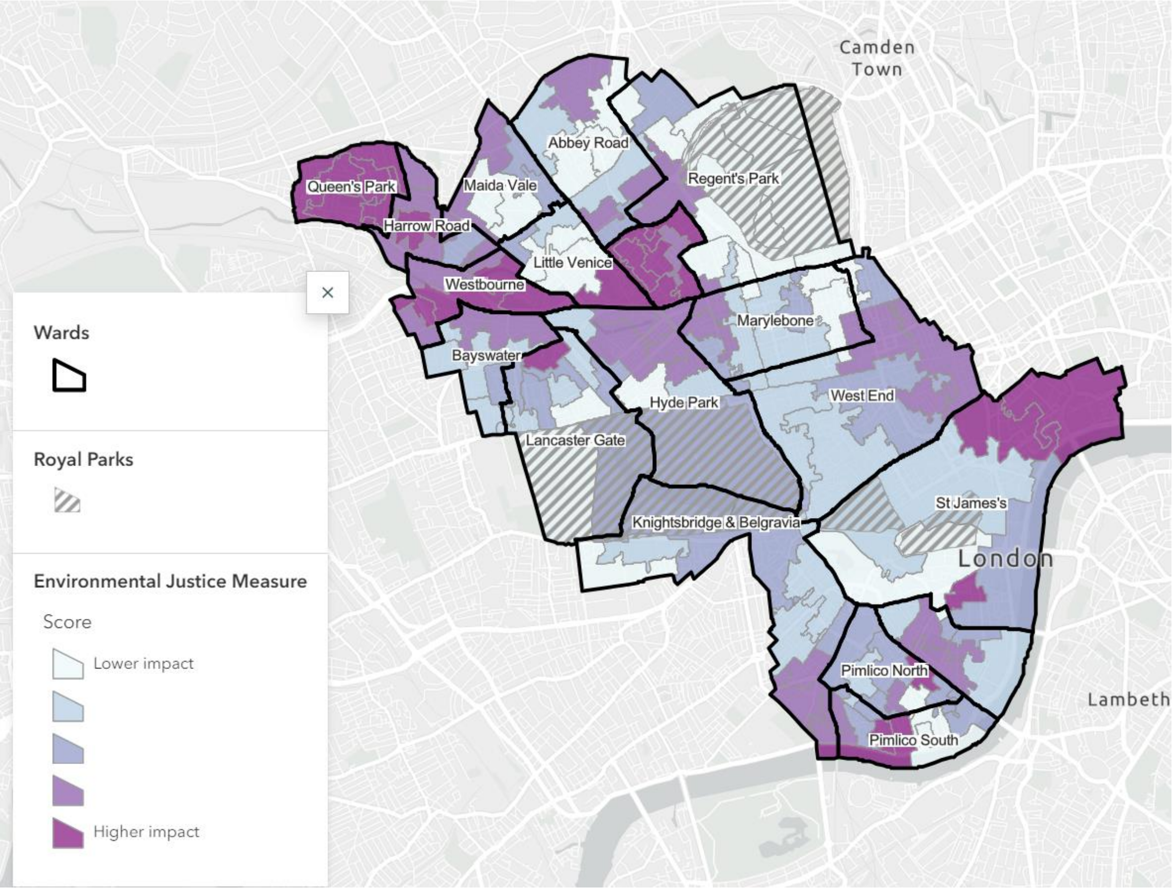


Figure 0—11 Environmental Justice Measure Map[7]

Fuel Poverty

The Department for Energy Security and Net Zero (DESNZ) provide yearly sub-national statistics on Fuel Poverty[8], with the most recent being published in 2023 for the reporting year of 2021 and uses the Low-Income Low Energy Efficiency (LILEE) fuel poverty metric. The LILEE indicator considers a household to be fuel poor if:

- Living in a property with an energy efficiency rating of band D, E, F or G as determined by the most up-to-date Fuel Poverty Energy Efficiency Rating (FPEER) Methodology; and
- Has a disposable income (income after housing costs (AHC) and energy needs) below the poverty line.

Statistics present that of the ~3.6 million households within London, 11.9% are these are believed to be living under fuel poverty conditions (431,400 households), which is below the England average of 13.1% for 2021. Westminster has a fuel poverty percentage below the London Average, of 10.9%, this is split by LSOA in Figure 0—12. It should be noted that although these trends will remain the same, there is a lag with publishing of fuel poverty data so recent energy price rises in 2022 and 2023 will not be captured, meaning the total level of fuel poverty is likely to be higher once reporting for these years are published.

[7] Image taken from Westminster City Council, Environmental Justice Measure https://storymaps.arcgis.com/stories/3f7bf2a160e047748e2526b3f2536902

[8] https://www.gov.uk/government/collections/fuel-poverty-statistics

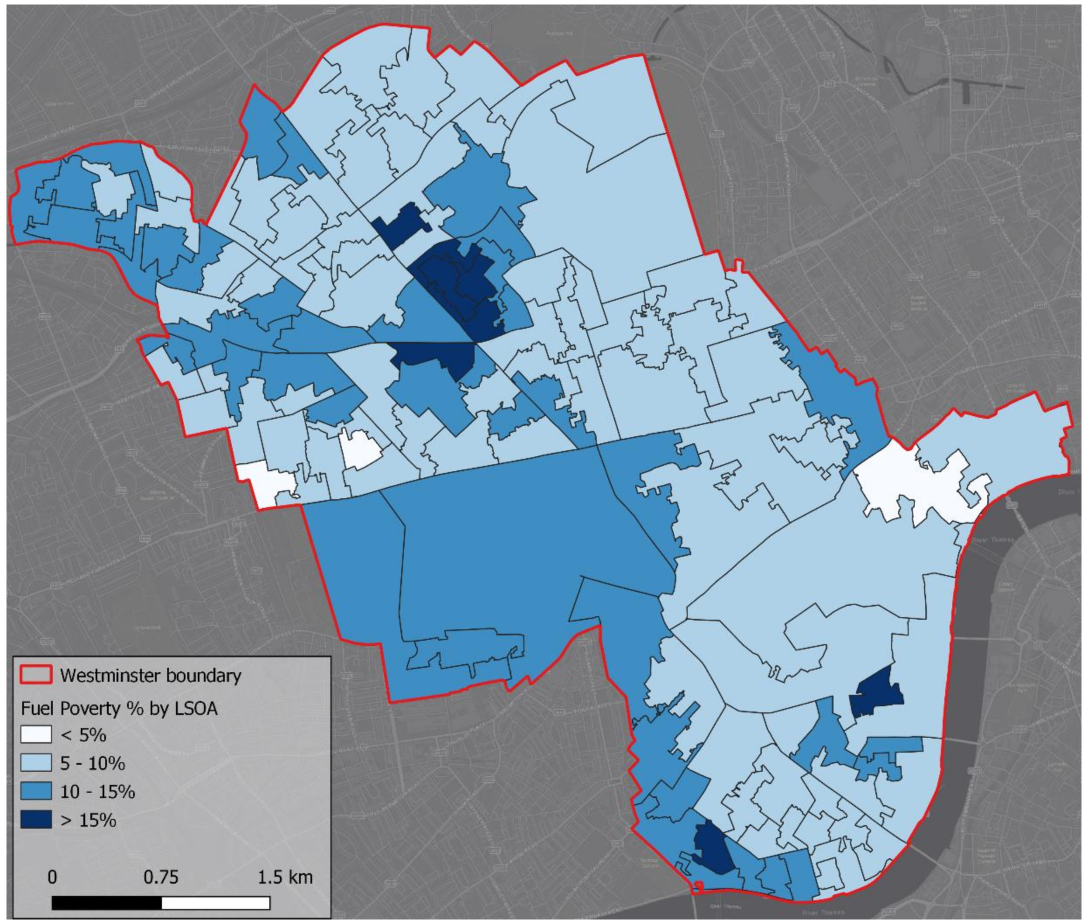


Figure 0—12 Map of LSOAs with percentage of households in fuel poverty.

The proportion of homes living in fuel poverty in Westminster in 2021 was up from 2020 - where Westminster had a fuel poverty percentage of 9.4%. This is likely to increase further following the energy price increases in 2021 and 2022 which resulted in many suppliers in the UK going out of business as well as the ongoing cost of living crisis in the UK.

Indices of Multiple Deprivation (IMD)

Indices of multiple deprivation (IMD) are widely used datasets within the UK to classify the relative deprivation (essentially a measure of poverty) of small areas[9]. Multiple components of deprivation are weighted with different strengths and compiled into a single score of deprivation. The Indices are comprised of a range of separate indicators, grouped into seven distinct domains whose deprivation scores were weighted to provide an overall Index of Multiple Deprivation:

- Income (22.5%)
- Employment (22.5%)
- Education, Skills and Training (13.5%)
- Health and Disability (13.5%)
- Crime (9.3%)
- Barriers to Housing and Services (9.3%)
- Living Environment (9.3%)

Data from the English indices of deprivation (2019) [10], ranks Lower Layer Super Output Areas (LSOA) with a rank of 1 the most deprived and the LSOA with a rank of 32,844 is the least deprived and in relation to deciles, LSOAs in decile 1 fall within the most deprived 10% of LSOAs nationally and LSOAs in decile 10 the least deprived 10%. The mean average decile score for all 128 LSOAs within Westminster from the English indices of multiple deprivation (2019) dataset provide an average IMD decile of 5.5.

This IMD decile score ranks Westminster 134th of 317 English local authorities with a population weighted average of 137th. IMD decile scores for all 128 LSOAs varied considerable from deciles ranging from 1 (most deprived) – 10 (least deprived), as shown in Figure 0—13.

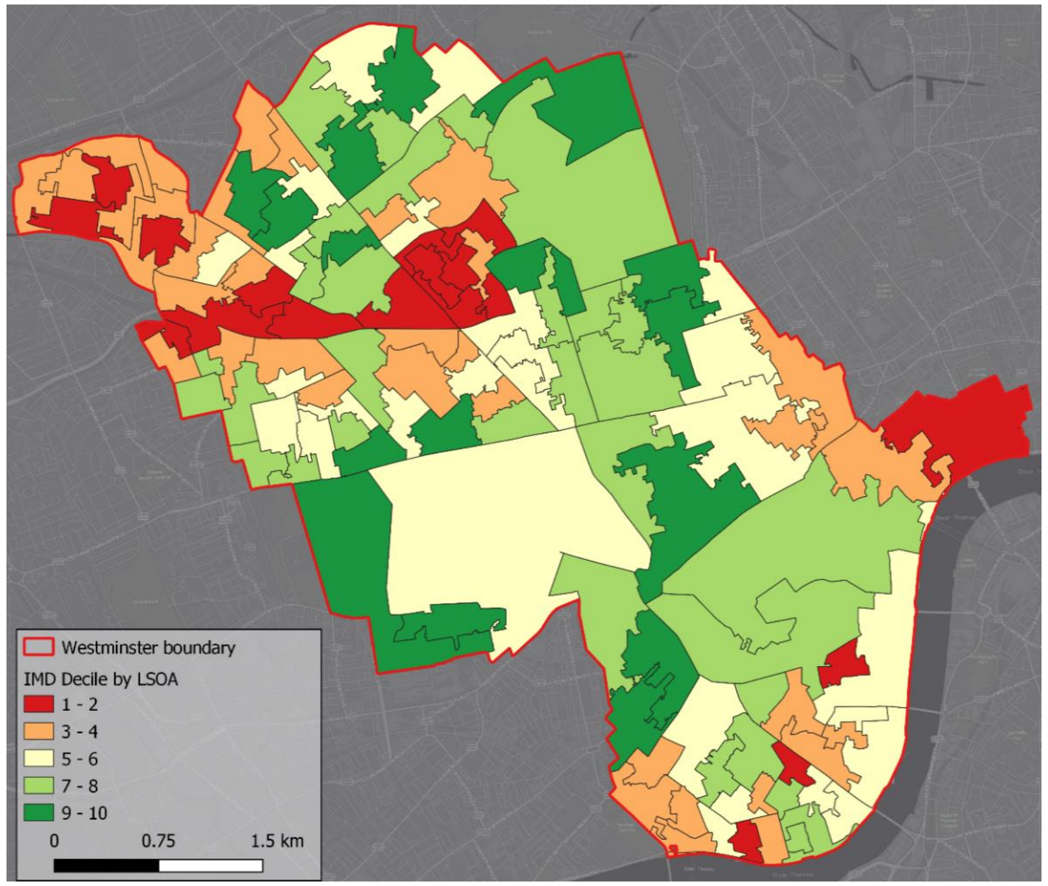


Figure 0—13 Map of LSOAs by IMD

It is noticeable that there is a lot of disparity of IMD scores across Westminster, showing the need to consider these factors in an LAEP to help ensure a just net zero transition.

Average decile scores for the seven individual indicator domains for Westminster are as follows:

- Income = 5.4
- Employment = 5.9
- Education, Skills and Training = 7.9
- Health and Disability = 7.6
- Crime = 5.0
- Barriers to Housing and Services = 4.5
- Living Environment = 1.9

The living environment score is the most noticeably poor performing measure and is one the LAEP will help address.

[9] https://data.cdrc.ac.uk/dataset/index-multiple-deprivation-imd

[10] https://www.gov.uk/government/statistics/english-indices-of-deprivation-2019

Summary of non-technical factors and their use

There is strong alignment between the WCC Environmental Justice Measure (EJM) and the national level data relating to fuel poverty and Indices of Multiple Deprivation. These measures highlight specific geographic areas (e.g. North Paddington) that need to be considered carefully, from a just transition perspective as well as having specific sensitivities for technology adoption. This is integrated into the analysis carried out in the LAEP. Notably areas with high fuel poverty and a high EJM impact will receive additional weighting for early-stage priority projects. Consideration of the type of project and associated costs to residents are key element of the LAEP in this context, as it is important to avoid putting non-cost effective additional financial burden on these communities.

Policy / Targets review

The policy review focused on finding the key decarbonisation documents/reports underlining the Net-Zero commitments per sector, spatially divided into national, regional (GLA), Local Authority (Westminster) and Great Estates organisational targets (within the local authority). An overview is presented in

National	Regional / GLA	Local Authority / Westminster	Westminster
Net zero by 2050	**Net zero by 2030**	**Net zero by 2030 WCC assets 2040 the rest**	Grosver **Net zer** 50% reduction impact • Cutting en • Reducing em • 60% carb purchased g
Key Policies	Key Policies	Key Policies	The Portı **Net zero by 2(** **with WC**
Legal commitment UK Climate Change Act (2019) • Sets legal requirements for the UK to achieve Net Zero by 2050 **Power** • Full decarbonisation of the power grid by 2035 **Buildings** • No new gas boilers will be sold by 2035 • Install 600,000 heat pumps per year by 2028 • Tighten MEES so that landlords cannot let properties with EPC lower than E **Transport** • End of sale of new petrol and diesel cars by 2035 • All cars must be fully zero emission capable by 2035	**Buildings demand reduction** • 37% reduction in total heat demand of domestic buildings, 39% for non-domestic buildings by 2030 • Heat demand halved of non-domestic buildings halved by 2034 **Retrofit** • 210,000 homes retrofitted each year between now and 2030 • 26,500 commercial/public buildings retrofitted each year between now and 2030 **Heat source** • No new gas boilers from 2026 • 2.2M heat pumps by 2030 **Heat networks** • 460,000 connections by 2030 **Transport** • 27% of reduction in car km • End of ICE sales by 2030 • Bring forward MTS outcomes by 10y **Rooftop PV** • 3.9GW by 2050	**Retrofit** • Deliver 'deep' energy efficiency retrofits improvements for 64,000 homes • 26,500 commercial/public buildings retrofitted each year between now and 2030 **Heat source** • 70% of homes and 60% of commercial buildings to be electrically heated by 2040 **Transport** • Cut travel by non-sustainable modes by a ¼ • Switch to 94% EVs **Waste** • Cut total waste by 40%, increase recycling rates to around 64% **Offsets** • Offset any residual emissions	The Howard d **No clea** The Cro **Net zer**

Figure 0—14.

National	Regional / GLA	Local Authority / Westminster	Westminster / Great Estates
Net zero by 2050	**Net zero by 2030**	**Net zero by 2030 WCC assets 2040 the rest**	Grosvenor Estate **Net zero by 2050** 50% reduction of total carbon impact by 2030 • Cutting energy use by 1/3 • Reducing embodied carbon by 50% • 60% carbon reduction in purchased goods and services
Key Policies	Key Policies	Key Policies	The Portman Estate **Net zero by 2030/2040 in line with WCC targets**
Legal commitment UK Climate Change Act (2019) • Sets legal requirements for the UK to achieve Net Zero by 2050 **Power** • Full decarbonisation of the power grid by 2035 **Buildings** • No new gas boilers will be sold by 2035 • Install 600,000 heat pumps per year by 2028 • Tighten MEES so that landlords cannot let properties with EPC lower than E **Transport** • End of sale of new petrol and diesel cars by 2035 • All cars must be fully zero emission capable by 2035	**Buildings demand reduction** • 37% reduction in total heat demand of domestic buildings, 39% for non-domestic buildings by 2030 • Heat demand halved of non-domestic buildings halved by 2034 **Retrofit** • 210,000 homes retrofitted each year between now and 2030 • 26,500 commercial/public buildings retrofitted each year between now and 2030 **Heat source** • No new gas boilers from 2026 • 2.2M heat pumps by 2030 **Heat networks** • 460,000 connections by 2030 **Transport** • 27% of reduction in car km • End of ICE sales by 2030 • Bring forward MTS outcomes by 10y **Rooftop PV** • 3.9GW by 2050	**Retrofit** • Deliver 'deep' energy efficiency retrofits improvements for 64,000 homes • 26,500 commercial/public buildings retrofitted each year between now and 2030 **Heat source** • 70% of homes and 60% of commercial buildings to be electrically heated by 2040 **Transport** • Cut travel by non-sustainable modes by a ¼ • Switch to 94% EVs **Waste** • Cut total waste by 40%, increase recycling rates to around 64% **Offsets** • Offset any residual emissions	The Howard de Walden Estate **No clear targets** The Crown Estate **Net zero by 2030**

Figure 0—14 Policy / targets review summary

National Policy context

In 2019 the UK government made a commitment is UK Climate Change Act (2019) to achieve Net-Zero by 2050. Following the commitment, a series of legislations and strategies have been adopted across sectors.

UK Net Zero Strategy released in October 2021 sets the target of fully decarbonising the UK power system by 2035, banning the sale of new gas boilers by 2035. Introduces a new target of reducing the emissions of public sector buildings by 75% by 2037. In transport there was previously a 2030 target for banning all new petrol and diesel cars, this has now shifted to all new vehicles to be zero emission capable by 2035.

The UK Heat and Building Strategy was also released in October 2021, outlines the strategy for decarbonising of domestic, public, industrial, and commercial buildings mainly through electrification of heat, utilising hydrogen gas whilst emphasising on energy efficiency.

Decarbonising Transport published in July 2021, outlines a plan to decarbonise the UK's transport system. It includes electrification of transport and development of nationwide charging infrastructure with the commitment that public transport will be zero-emissions by 2050.

The Energy Security Bill was introduced to Parliament on 6th July 2022. It introduces a regulatory framework for heat networks to facilitate heat network zoning and incentivising the use of low carbon fuels in transport.

The Energy Act 2023, called the biggest piece of energy legislation in the UK's history. Introduced in 15 parts, provides a wide range of provisions for new energy activities, regulations, heat networks and energy performance of buildings. Following is a summary of relevant parts:

- Regulation of new technology including low carbon heat schemes, renewable transport fuel obligations and removal of greenhouse gases
- Regulation of heat networks: designating a regulator for heat networks and assigning heat network zones; creation of a Heat Network Zones Authority and zone coordinators; an enforcement powers and imposition of penalties
- Energy performance of premises and energy savings opportunity schemes

Greater London policy context

The London Plan 2021 sets out the overarching framework of how London will develop over the next 25 years. It sets out significant strategy, actions, and targets across sectors on addressing the Climate Emergency.

The plan, published by the GLA in 2021, includes:

- Establishing an energy hierarchy that prioritises reducing use and improving efficiency before relying on renewables and offsetting. The plan is targeting emissions reduction substantially beyond the standard Building Regulation requirements.
- The ‘Be clean’ aspect focusses on heating infrastructure and the requirement to utilise local energy resources. Heat networks are identified to as a key heating solution that enables the use of waste heat.
- Identifying Heat Network Priority Areas within which new developments must be able to facilitate a future connection to a heat network.
- The strategic target of 80% of all trips in London to be made by foot, cycling or public transport by 2041.

In 2022, GLA published a report outlining the possible pathways for London to become net-zero carbon by 2030. It sets out the high level of ambition and accelerated action that will be necessary to reduce emissions across sectors, including targets such as:

- A 37% reduction in heat demand from 2020 baseline delivered through retrofit interventions by 2030.
- 60% of domestic heat demand to be met by low carbon systems by 2030.
- A 27% reduction in car travel by 2030.

Westminster City Council policy

In 2019, the City of Westminster declared Climate Emergency which sets targets for Westminster City Council to achieve Net Zero emission by 2030 and for the City to follow by 2040. The Westminster Climate Emergency Action Plan sets out comprehensive actions for reducing carbon emissions across the City in key sectors, namely buildings, energy affordability, renewables energy uptake and sustainable transport. To achieve net zero in 2040, the plan has many key action points spread across the energy system. One of the items addresses the inefficient nature of much of Westminster’s historic building stock, with the aim of delivering extensive ‘deep’ energy efficiency retrofit improvements in around 64,000 homes. The Pimlico District Heating Undertaking is the oldest district heating system in the UK and is owned and operated by WCC. The council is exploring various decarbonisation options including interconnection with other heat networks and the transition to water source heat pumps to provide low carbon heat. The Sustainable City Charter recognises the dominance of the non-domestic properties in Westminster’s carbon emissions and seeks to address this through business led climate action pledges – including commitment to net zero by 2040 or earlier. Some of Westminster’s biggest emitters have already signed up, showing the appetite for this innovative approach to addressing non-domestic decarbonisation.

North Paddington is a key geographic focus area for Westminster, with the North Paddington Programme aiming to improve both service delivery and outcomes in the North Paddington area. The area contains three wards of Westbourne, Harrow Road and Queens Park - these consistently report worse indicators than in other parts of the borough. The programme is piloting an area-based approach to the Council’s work, with the objective of ensuring the delivery of Council services is appropriate to local need and joined-up between departments. The two key outcomes are to:

1. Increase life expectancy in North Paddington relative to the rest of Westminster.
2. Increase well-being in North Paddington area, measured by a reduction in the indices of multiple deprivation.

The programme is adopting the future neighbourhood’s model, which takes a place-based approach and is underpinned by strong community engagement. More details of how this links into the delivery of the LAEP is provided in **Error! Reference source not found.**.

The Westminster City Plan

The existing Westminster City Plan was adopted in 2021. This includes a section on Energy policy which largely follows the Greater London Authority (GLA) policies, described in the following sections. Its primary focus for Energy influences new build developments through the planning process.

Since Westminster’s change of administration, a partial review to update this has been underway. This update focusses around affordable housing policy and retrofitting over demolition, as well as site specific guidance for 4 site allocations which will be formally consulted early next year. A full review of the City Plan will start from 2025 onwards.

Westminster local targets

Within Westminster, important stakeholders such as the Great Estates and Housing Associations have developed emissions reduction targets and implementation timelines. In detail:

- Grosvenor Estate
  - Grosvenor has a target to reduce the total carbon emissions by 50% by 2030 (net zero operational carbon) and a net zero carbon portfolio (operational carbon and embodied) by 2050. Their focus will be in three areas: cutting energy use in their buildings by one third, reducing the embodied carbon intensity by 50% and cutting the carbon intensity of purchased and good and services by at least 60%.
- The Portman Estate
  - Portman has an aspiration to reach net zero carbon in all activities between 2030/2040 in line with targets set by Westminster City Council.
- The Howard de Walden Estate
  - Howard de Walden does not have a net zero target but focuses more on energy efficiency data reporting of its properties following the Streamlined Energy and Carbon reporting (SECR) which is measuring carbon footprint across Scopes 1, 2 and 3.
- The Crown Estate
  - The Crown has committed to net zero by 2030, and they are currently reporting Scope 1, 2 and 3 emissions.
- Westminster Housing Association
  - It is a non-profit advocacy group representing over 240 members from across Westminster's built environment. They have a shared goal to reduce operational carbon emissions to ensure Westminster becomes a net zero city by 2040.

Stakeholder engagement

A robust and targeted process of stakeholder engagement has been adopted to suit the local challenge. The process has helped to present the existing system, identifying the correct starting point for LAEP and influencing the outcome. It has helped to identify the short, medium, and long-term list of actions and name the owners.

This section will detail the engagement activities and highlights some key outcomes from our activities. Throughout the report it has been highlighted how these engagements have influenced the LAEP. Such engagement is vital as the LAEP cannot be delivered by WCC alone and requires the partnership with all stakeholders; from individuals within Westminster and neighbourhood groups, to major land owners such as the Great Estates to national government and the utilities.

The stakeholder engagement approach was informed by LAEP guidance documents produced by Energy Systems Catapult, a summary of this is provided in Figure 0—15.

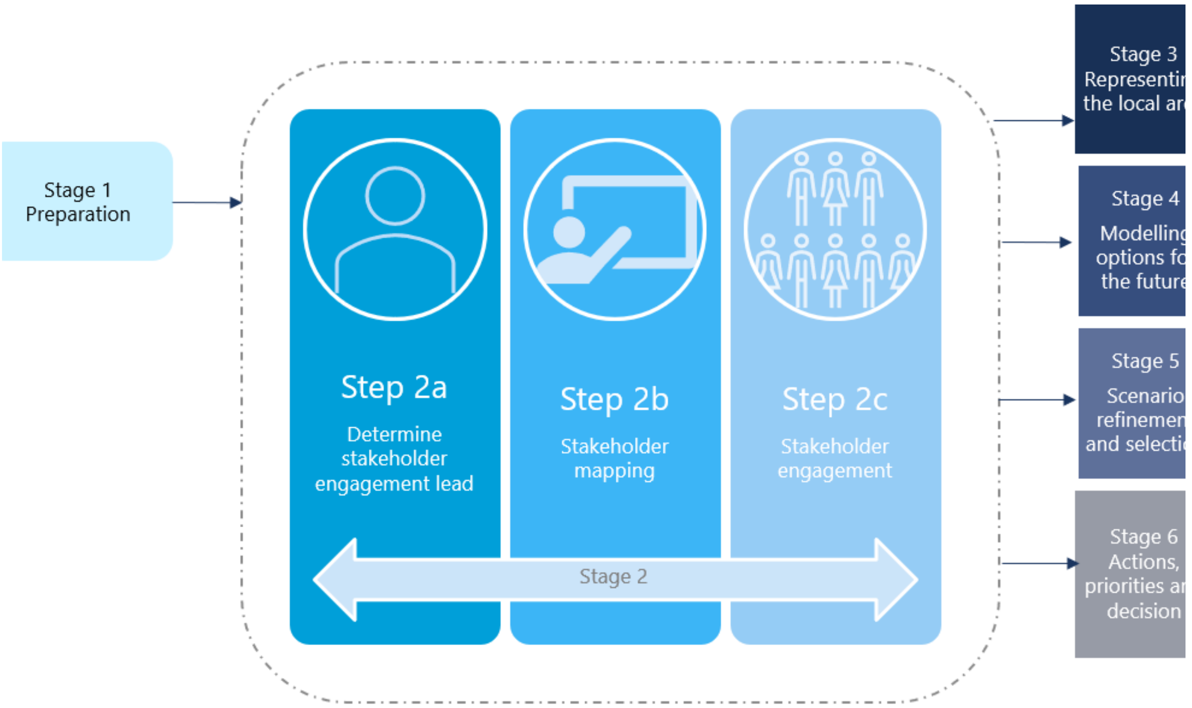


Figure 0—15 Stakeholder engagement stages - Source: Creating a LAEP guide, ESC.

Stakeholder identification and mapping

Stakeholder engagement process has been adopted to meet the requirements of creating a LAEP guidelines. The following summarises the approach taken:

- Development of stakeholder long list considering organisational / institutional stakeholders and wider public
- Analysis of stakeholders incorporating interest / influence; power / urgency / legitimacy; and proximity to LAEP.
- Review if any stakeholders should be included as part of the LAEP governance.
- Creation of a visual map of stakeholders to understand relationships.
- Agree an engagement plan with Westminster setting out: key stakeholders, methods of engagement, roles, timetable, risks.
- Generally, raise awareness of LAEP ambitions for more effective dialogue throughout.

Relevant stakeholders were identified jointly with the Westminster and the project team, this was informed by a mapping exercise summarised in Figure 0—16.

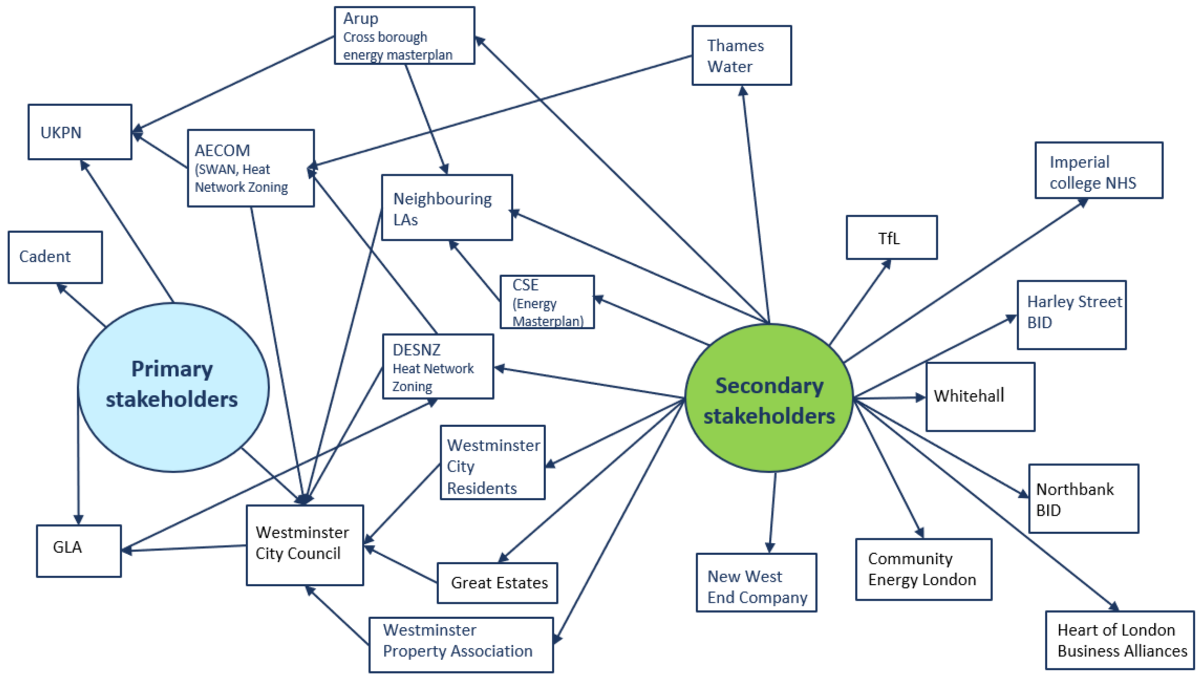


Figure 0—16 Stakeholder map

These stakeholders were engaged with to enable a better understanding of their current roles and responsibilities; existing decarbonisation targets and their objectives regarding the development of the LAEP. Specific stakeholders provided data regarding energy demand or supply and associated energy infrastructure.

To establish priorities, we held several stakeholder engagement sessions throughout the project. These sessions included focused meetings to gather information and understand future considerations, as well as collaborative workshops for broader discussions, where we identified common challenges, collaboration opportunities, and potential actions.

We engaged with stakeholders across the Westminster's various teams as well as the Business Improvements Districts, the Westminster Property Association, and other organisations across the energy sector, notably Cadent and UKPN, to gather relevant data and establish plans, objectives and priorities. This engagement was ongoing throughout the project to allow it to inform and influence at all key stages as the plan developed.

Key workshops were held with the stakeholders at the end of LAEP Stage 3 (baselining the local area), Stage 4 (modelling options for the future) and Stage 5 (scenario refinement). These provided an opportunity to present the LAEP progress and gather feedback on challenges and opportunities.

Stage 3 workshop - we presented the current energy systems for Westminster to the stakeholders. In the breakout sessions, we discussed priority areas for intervention and the associated challenges.

Stage 4 workshop- modelling options and future scenarios were discussed with the stakeholders and 4 scenarios were selected for modelling.

Stage 5 workshop- modelling outputs were presented to the stakeholders along with a series of priority projects and an action plan. The workshop was focused on 4 themes:

- Heat decarbonisation
- Electricity generation and storage
- Retrofit and insulation
- EV charging and transport

This workshop provided an extensive opportunity for engaging with both secondary and primary stakeholders on the above themes and exploring finer details regarding potential areas of collaboration, opportunities, and challenges.

Stakeholder insights

Suggestions, challenges, and opportunities captured during the final workshop presented in Appendix C.

Scenario definition

This section details the various scenarios explored within the LAEP. Exploring how the scenarios were selected, their key characteristics and the final scenario that was explored and is the selected LAEP pathway.

Scenario selection process

The LAEP process started off with four initial core scenarios:

Falling Short – is considered the slowest credible pathway to decarbonisation. Generally, avoids fully tackling heat decarbonisation. This is the only scenario which does not attempt to hit 2040 decarbonisation.

High Heat Networks – focuses on centralised large scale heat networks to decarbonise building heat demand. The scenario substantial strategic input for delivery of large-scale heat networks.

Consumer Transformation - decarbonisation is driven by individual's adopting low carbon technologies and high levels of behavioural change. This generally focuses on property and building level solutions than the larger scale heat network options.

Accelerated Green – is a GLA scenario that focuses on early decarbonisation, maximising system decarbonisation by 2030, achieving a 78% carbon reduction at this point.

The testing of the core scenarios is the first element of appraising different decarbonisation pathways for Westminster. After these initial scenarios are tested, they inform the final LAEP Scenario, this process is summarised in

Figure 0—1 Scenario modelling approach overview

.

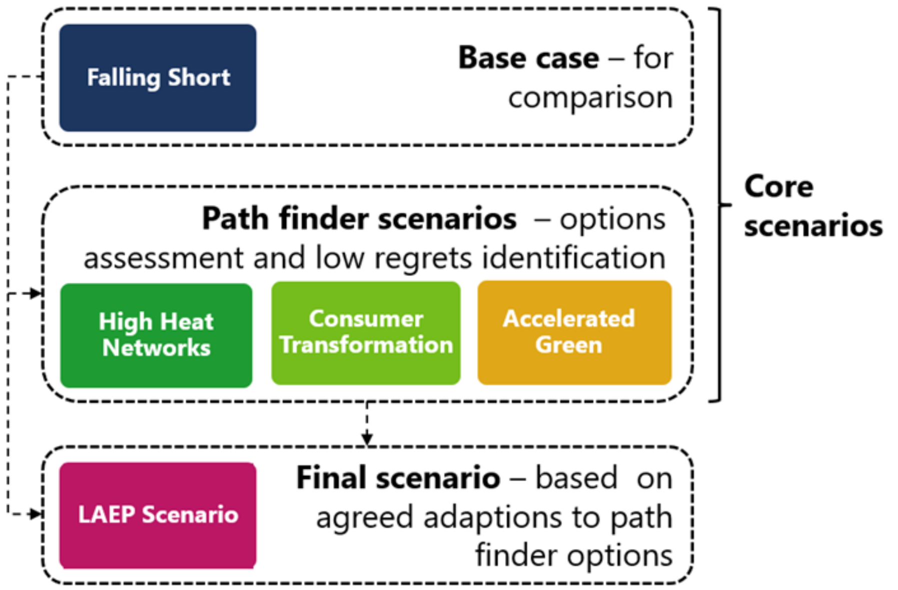


Figure 0—1 Scenario modelling approach overview

This final LAEP Scenario draws upon elements of the other scenarios and is explored in most detail in this section (0). Before the final scenario is examined more details of other core scenarios are provided in the following section. However, first it is important to note that large scale deployment of hydrogen is not considered.

Exclusion of hydrogen

In the scenario assessment hydrogen is not considered for heating. There are two main challenges for largescale deployment of hydrogen in Westminster's gas network:

- It is **not deployed at scale in the UK** – with the UK Government still focusing on research[11]. This raises questions about deliverability in the 2040 timescale for Westminster's decarbonisation. Blending of 20% hydrogen and biomethane into the gas grid to reduce the carbon emissions in the short term is awaiting central government decision – with the consultation having closed in autumn of 2023[12]. However, this reduction in carbon emissions, whilst potentially important in the short term, does not enable the 2040 target to be met.
- It **requires a regional strategy** rather than just Westminster, due to the nature of gas network interconnectivity.

Additionally, two large trial projects for hydrogen heating deployment in Whitby and Redcar were scrapped this year – showing the challenges for large scale hydrogen adoption (including public opposition). There is also the broader national context of the National Infrastructure Commission recommending that "government should not support the rollout of hydrogen heating"[13], as well as over 50 independent studies not presenting compelling evidence for large scale use of hydrogen for heating[14]. These factors mean hydrogen have a very high level of uncertainty, which is particularly challenging given the timescales for decarbonisation that are being aimed at in Westminster.

Consequently, Westminster City Council made the decision to exclude hydrogen for use in heating, but it is considered for some transport (i.e. HGVs, buses and coaches). However, it should be noted that many of the early changes across all scenarios will be hydrogen compatible. So, if there are any major change in the wider UK hydrogen strategy it could be included in an updated plan. Additionally, the plan does not include the decommissioning of gas networks, which would be an additional cost for a non-gas scenario outside of the LAEP scope.

[11] Department of Energy Security and Net Zero, 2023: Hydrogen Strategy Update to the Market: August 2023. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1179651/hydrogen-strategy-update-to-the-market-august-2023.pdf

[12] Department of Energy Security and Net Zero, 2023: Hydrogen Blending into GB Gas Distribution Networks. https://assets.publishing.service.gov.uk/media/650057d81886eb00139771f8/hydrogen-blending-into-gb-gas-distribution-networks-consultation.pdf

[13] National Infrastructure Commission, 2023: Technical Annex: hydrogen heating. https://nic.org.uk/app/uploads/NIA-2-Technical-annex-hydrogen-heating-Final-18-October-2023.pdf

[14] Rosenow, A meta-review of 54 studies on hydrogen heating, Cell Reports Sustainability (2023), https://doi.org/10.1016/j.crsus.2023.100010. https://northeastbylines.co.uk/wp-content/uploads/2023/12/PIIS2949790623000101.pdf

Falling Short

The Falling Short scenario it is the only scenario which does not attempt to hit the 2040 decarbonisation target. It is used as a counter point to give context to the other scenarios. A summary of how it addresses key components of the energy system is provided in

Table 0—1. This provides a qualitative indication of actions taken in different energy system elements, with an arrow pointing to green indicating high prioritisation for delivery of carbon reduction, yellow is neutral to the current system and red worse than present day.

Table 0—1 Summary of strategy for the Falling Short scenario

Fabric improvement	Low levels of fabric improvement, targets an EPC of D (including consideration of heating system)
Heat networks	Relatively high deployment but still lowest of all scenarios. Targets ~45,000 connections in total (2050).
Heat pumps	Minor increase of ~3000
Car ownership reduction	Maintains current level and current mileage.
EV charger numbers	4.5 chargers per space with 20% coverage in car parks.
Renewable deployment	61 MW rooftop PV (equal share of GLA 2 GW target), equates to ~4% of Westminster roof space.
Flexibility / diversity	No substantial change, standard assumptions for diversity.

Whilst Falling Short does not hit net zero by 2040 there are substantial improvements. Renewable deployment is a relatively easy win, which increasingly makes economic sense with increased energy prices. EV ownership and associated charger numbers are high, with strong regional policy helping to drive adoption. Low levels of fabric improvement and change in heating systems, which are more intrusive technologies to install, are the limiting elements missing from this scenario – which are required for net zero.

Flexibility and diversity are two important components of the energy system. Although they are not central to the falling short scenario it is useful to clarify what they mean in an energy system context.

Flexibility refers to the ability to change generation or consumption/demand patterns to support the electricity network. In fossil fuel-based energy systems, with the ability to easily dispatch additional generation to match demand there has traditionally been relatively little need for demand to be flexible. However, renewable generation is generally not dispatchable and, often more importantly in the local context, the electricity network cannot always distribute the electricity required at times of peak demand. This issue will increase with the electrification of heat and transport. Higher flexibility refers to either demands being able to vary to match what the grid can supply or for local technology to provide additional supply. In the context of Westminster batteries are the key technology considered for this in the electricity network.

Diversity refers to natural differences in demand. This accounts for the fact that not everyone in Westminster will be using all of their appliances at once, e.g. every household charging an EV, having a shower, cooking a meal, using the tumble dryer and having the heating on full at the same time. Currently, particularly with electric heating, electricity networks assume a very low diversity. This means the electricity network must have capacity to supply the full demand for heat to every consumer on the network at any time if electrification of heating is to take place. If this is not the case upgrades to the electricity network would be required before a building could switch from a gas boiler to a heat pump.

As energy networks become more advanced with integration of technology like smart meters and distributed storage, there is more opportunity for consumers to directly supply flexibility services and for a more detailed understanding of diversity. This shift in how the electricity system functions is increasingly being captured by the phrase Smart Local Energy Systems (SLES). In some of the higher electrification scenarios increased flexibility and assuming greater diversity in demand[15] is key to helping reduce high electricity network reinforcement costs.

High Heat Networks

This scenario focuses on a large, centralised solution of heat network deployment to provide low carbon heating. This is the largest difference between it and Falling Short, which allows net zero to be hit by 2040. Westminster City Council assets are considered separately to allow for them to hit a 2030 decarbonisation date, aligning with the Council's target. Table 0—2 provides a summary of the key actions in the scenario.

Table 0—2 Summary of strategy for the high heat network scenario.

Fabric improvement	Focus on less invasive retrofit – e.g. windows rather than internal wall insulation. Target ~15% space heat demand reduction.
Heat networks	Very high connection to heat networks, focus on large heat networks.
Heat pumps	Focus on heat networks rather than heat pumps – large centralised heat pumps are one of the major technologies considered for heat networks
Car ownership reduction	Use and mileage is similar to current levels.
EV charger numbers	4.5 chargers per space with 20% coverage in car parks.
Renewable deployment	78 MW rooftop PV – 25% increase on GLA target. Equates to ~5% of Westminster roof space.
Flexibility / diversity	Some increase in flexibility, based around EVs. Large heat networks with a high typology mix.

The high reliance on centralised heat networks and the associated time scales for deployment means large carbon reductions come close towards 2040, with step changes as heat networks are connected. Some limited smaller communal systems, a degree of fabric improvement, high EV deployment and a large adoption of PV help contribute to some intermediate decarbonisation. It should be noted that the extensive pipework required to be installed would also result in large scale disruption as would the switch of system at a property level. The coordination required for this wide transition would be highly challenging.

One of the major developing policy levers for heat network connection is the UK Government's proposed policy and ongoing work on the Heat Network Zoning programme. Although not past into legislation yet it indicates that 100 MWh/yr of heat demand at building level could result in mandated connection to heat network. Westminster's building stock is examined in relation to this in Table 0—3.

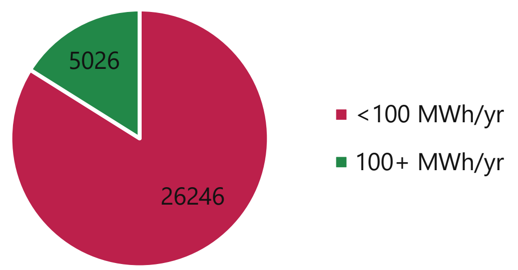
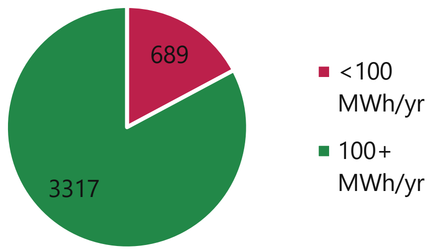
Only 16% of buildings in Westminster fall into the demand level which could be mandated[16], however, if 100 MWh/yr was adopted, these buildings account for 83% of the total heat demand. This number will slightly reduce as buildings become more efficient, due to improved insulation being a

[15] It should be noted that these assumptions are based on engineering standards such as those used in Sweden and Denmark for heat networks and the CIBSE standards in the UK.

[16] It should be noted the precise nature of this mandate is still being finalised but it provides a useful indication.

major component of the LAEP. However, it shows the widespread impact this policy could have in Westminster if adopted. Even if such a strong policy lever were to exist the scale of heat network connection shown in this scenario would still be challenging to achieve.

Table 0—3 Breakdown of buildings and heat demands in Westminster considering the UK Government potential demand that can be mandated for heat network connection.

Number of buildings in Westminster that exceed 100 MWh/yr heat demand and those with <100 MWh/yr demand	Split of heat demand (GWh/yr) in Westminster that comes from buildings that exceed 100 MWh/yr and those with <100 MWh/yr demand
	

Consumer Transformation

The Consumer Transformation has more incremental decarbonisation than the high heat network scenario. Again, net zero is hit by 2040 and the 2030 decarbonisation of Westminster City Council assets more readily aligns with the faster decarbonisation seen in this scenario. A summary of the key elements is provided in Table 0—4.

Table 0—4 Summary of strategy for the Consumer Transformation scenario.

Fabric improvement 	More intrusive measures considered, minimum of EPC C target through fabric efficiency.
Heat networks 	Heat networks are still prevalent, due to high demand density but heat pumps can be deployed in heat network zones to enable early progress.
Heat pumps 	Focus in areas of lower heat density. Heat pumps for early progress in low DH confidence areas.
Car ownership reduction 	Modal shift in car ownership and use, 27% reduction in miles by 2040. Reflected in 27% drop in ownership.
EV charger numbers 	4.5 chargers per space with 20% coverage in car parks.
Renewable deployment 	90 MW – 50% increase of GLA target. Equivalent of ~6% of roof space.
Flexibility / diversity 	High levels of peak shaving and diversity. Heat pump diversities align to standard commonly used for DH.

Heat networks are still very important in the Consumer Transformation scenario - given the high heat density of Westminster. However, communal level heating is more widely spread as are individual property level solutions. This is due to individuals and businesses taking a more active role of adopting net zero technologies. Westminster is well set up for this with a few large landowners (such as the Great Estates) being well placed to influence low carbon heating systems at a more communal or building scale. Stakeholder engagement during the LAEP highlighted that many of these key stakeholders are developing such strategies and schemes. These could act as key case studies for greater role out across Westminster.

Flexibility and diversity become more central in the Consumer Transformation scenario. This includes offering of flexibility services from more engaged consumers, through technologies like batteries and using energy in a way which puts lower stress on energy networks. These engaged consumers would respond to signals, such as electricity price, to alter the time they use energy – flattening the energy demand.

This flattening of energy demand helps to improve what is termed the diversity factor. The diversity factor is important as it used to calculate the size of energy infrastructure required. The Consumer Transformation scenario has a very high level of electrification, which means having a high diversity factor is important to prevent widespread electricity infrastructure. A case in point is the electrification of heat with heat pumps, currently the DNOs assume no diversity in heat pumps. This would result in very high levels of upgrade in the Consumer Transformation scenario, particularly in residential areas identified for individual heat pumps. In this scenario diversity benchmarks more generally used for heat networks are applied to individual heat pump systems to reflect greater interaction with the energy system. Greater diversity and flexibility are also seen in other aspects of the energy system as well, including vehicle charging but these are also present in the High Heat Networks scenario as they are better established in DNO standards.

Accelerated Green

Accelerated Green is the most ambitious scenario and follows the London wide decarbonisation trajectory, illustrated in Figure 0—2. This was highlighted by the GLA as their preferred scenario for their 2030 net zero target from their 2022 study.

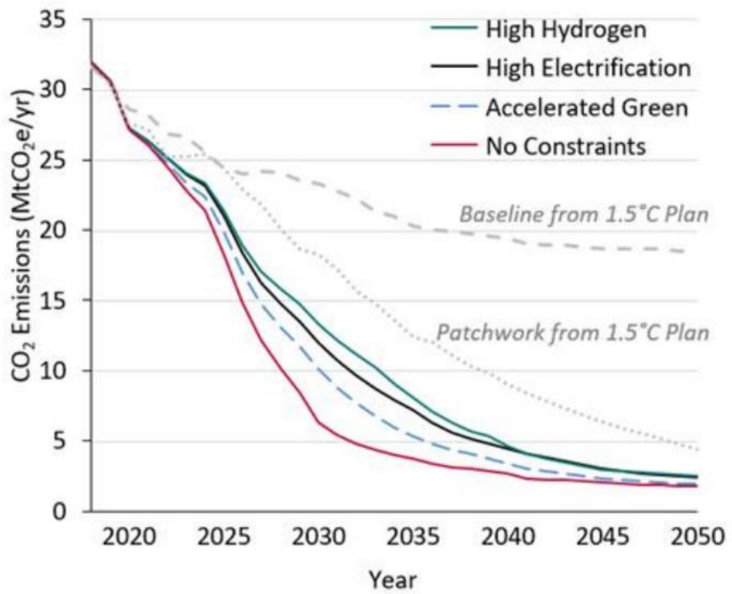


Figure 0—2 Different GLA decarbonisation pathways[17]

To hit this ambitious early decarbonisation the technology selection is a combination of the High Heat Networks and Consumer Transformation scenarios, this is presented in Table 0—5. The main difference with Accelerated Green is the high cost associated with the level of decarbonisation by 2030. It is also questionable whether there is sufficient workforce to implement the changes required.

[17] Element Energy on behalf of Greater London Authority, 2022: Analysis of a Net Zero 2030 Target for Greater London. https://www.london.gov.uk/sites/default/files/nz2030_element_energy_final.pdf

Table 0—5 Summary of strategy for the Accelerated Green scenario.

Fabric improvement	Focus on windows (loft and cavity if appropriate). Aim to create 40% heat demand reduction, coupling fabric and behaviour change.
Heat networks	Minimum ~46% of buildings connected based on scenario. Short time frames promote technology – 73 MWh/yr demands connected if in zones.
Heat pumps	Considered where heat networks are not viable.
Car ownership reduction	Modal shift in car ownership and use, 27% reduction in miles by 2030. Reflected in 27% drop in ownership.
EV charger numbers	4.5 chargers per space with 20% coverage in car parks.
Renewable deployment	Assumed to be 90 MW, direct translation of Accelerated Green would be 118 MW but Westminster is not the most suitable borough for PV deployment.
Flexibility / diversity	Very high levels of peak shaving and high diversity. Heat pump diversities align to standard commonly used for DH.

Final scenario selection

The chosen scenario aims to balance the cost implications of certain items, and while still extremely ambitious, aims to realistically balance ambitions around Heat Networks and the shifting role of the consumer, not seeking the maximum 'changes' for any area, mostly due to the 17-year timeframe and some of the logistical challenges in Westminster. A summary is provided in Table 0—6

Table 0—6 Summary of strategy for the Final LAEP scenario.

Fabric improvement	Focus on windows (loft and cavity if appropriate). Aim to create 40% heat demand reduction, coupling fabric and behaviour change.
Heat networks	Minimum ~46% of buildings connected based on scenario. Short time frames promote technology – 73 MWh/yr demands connected if in zones.
Heat pumps	High uptake in non-flat domestic properties. Communal heat pump solutions also see high uptake in flats and other properties which contain multiple properties.
Car ownership reduction	Modal shift in car ownership and use, 27% reduction in miles by 2030. Reflected in 27% drop in ownership.
EV charger numbers	4.5 chargers per space with 20% coverage in car parks.
Renewable deployment	90 MW – 50% increase of GLA target. Equivalent of ~6% of roof space.
Flexibility / diversity	High levels of peak shaving and high diversity. Heat pump diversities align to standard commonly used for DH.

The final LAEP scenario is a combination of the Accelerated Green, Consumer Transformation and High Heat Networks scenarios. However, what was apparent from comparing these scenarios was a high sensitivity in cost implications of certain items – particularly in relation to fabric retrofit. Focusing on the properties with the poorest fabric, indicatively those with an EPC of E-G, the total fabric improvement cost was ~£950 million. If a broader selection of properties is considered, indicatively aligning to EPC D-G, the cost of fabric improvement rises to ~£3.2 billion. The high cost associated with this fabric improvement sensitivity is exacerbated in Westminster due to the age of the building stock and its heritage status. A somewhat lower fabric efficiency can in some instances be offset by a different heating system configuration.

To explore these differences two sensitivities are explored:

- **High ambition** – this maximises fabric improvement, which carries with it a high up-front cost. This considers all properties for fabric improvement which generally aligns to EPC D and below.
- **Low ambition** – this sensitivity targets only the least efficient properties in terms of overall efficiency performance. This generally aligns with an EPC E and below but more cost-effective measures such as cavity wall and loft insulation are considered across all building stock.

Where relevant results will be explored based on these sensitivities, with the final values generally sitting between the sensitivities. The Final Scenario takes a mixed approach, with high changes for all key areas of action but generally not the maximum observed in the test scenarios for any of the elements. The only exception to this is the deployment of solar, which is favoured due to the payback rates and cost-effective early decarbonisation. There are various constraints which could limit this once more detailed feasibility studies are undertaken, including roof space requirements for technologies like heat pumps so a sensitivity is explored to ensure this is accounted for. More details can be found in 0.

Fabric Retrofit

Introduction

This section focuses on the existing fabric make-up of the buildings in Westminster and the strategic recommendations for improvement. The section is split out between Domestic and Non-Domestic buildings; each section sets out the baseline context and the recommended improvements from the scenario modelling with priority project opportunities identified. Multiple datasets are used in this process, however, two core datasets form the basis of the analysis. These are Parity[18] data for the domestic sector and Non-Domestic Analytics for the non-domestic sector (provided by Energy Savings Trust[19]). These two datasets also provide the underlying data for the heating system analysis along with the fabric retrofit.

Domestic buildings retrofit

Domestic - Existing Fabric

As set out in the Baseline section of this report, over 60% of the domestic stock in Westminster has an Energy Performance Certificate (EPC) D and below. These areas require greater attention to improve their energy efficiency and should be targeted first.

The following maps (Figure 0—1) provide an LSOA-level summary of the percentage of different building fabric make-ups in the Westminster domestic properties. Table 0—1 provides the percentage of domestic properties with various fabric make-ups in Westminster, shedding light on the scale of challenges regarding energy efficiency improvement. The fabric make-ups include uninsulated solid walls, unfilled cavity walls, single glazing, and uninsulated roofs. They highlight areas with greater potential for energy efficiency improvement and can help to target specific retrofit programmes.

Energy efficiency improvement is required to ensure the optimal performance of low-carbon technologies, such as heat pumps. This improvement enables a smaller heating system and lowers the strain on distribution networks.

Table 0—1 Share of properties with different building fabrics with potential for improvement.

Single glazing	Uninsulated roofs	Uninsulated solid walls	Unfilled Cavity
43%	21%	74%	9%

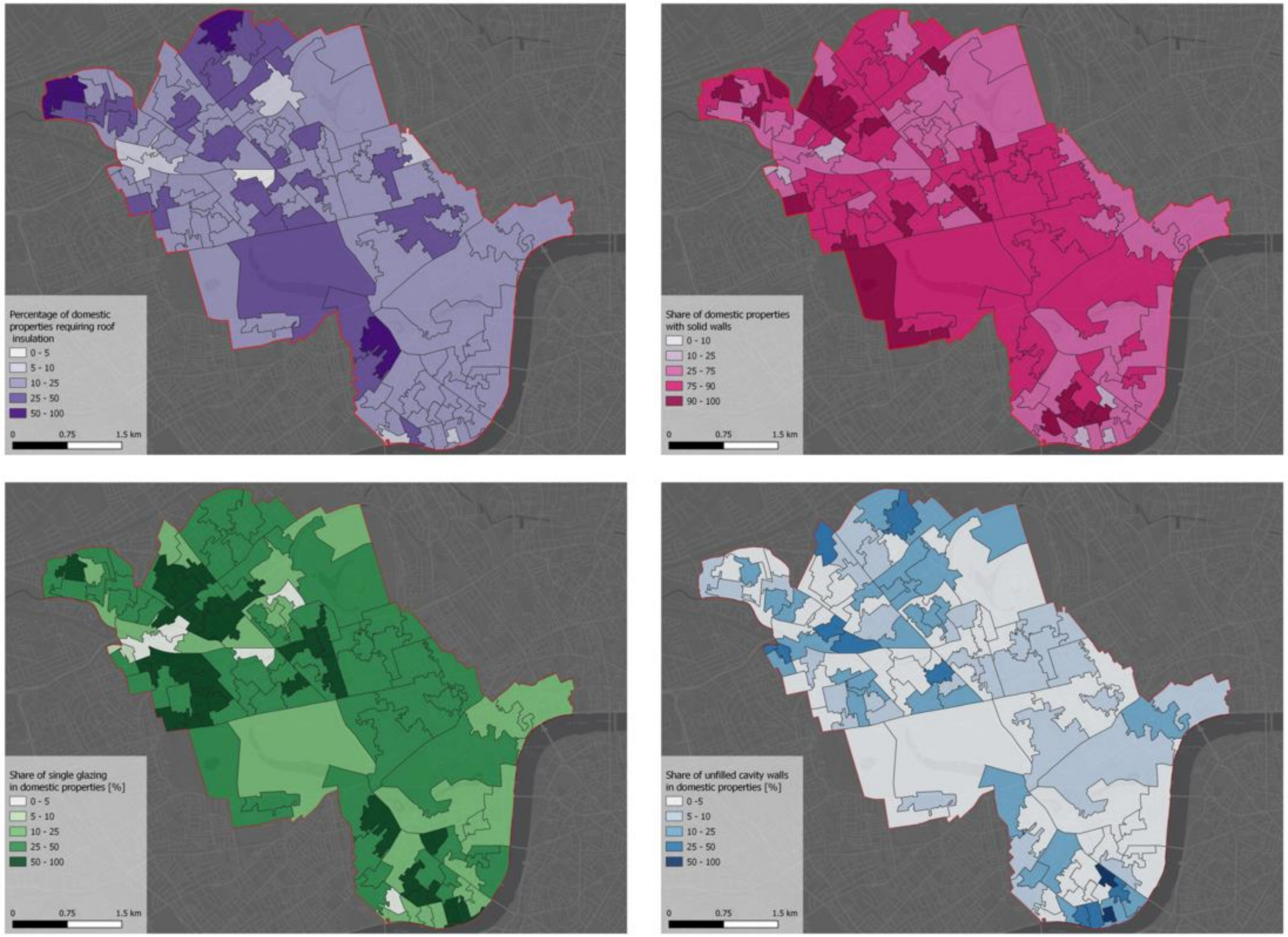


Figure 0—1 LSOA level data regarding the percentage of: uninsulated roof (top left), uninsulated solid walls (top right), single glazing (bottom left) and unfilled cavity walls (bottom right)

[18] https://parityprojects.com/

[19] https://energysavingtrust.org.uk/

Domestic - Strategic scale review of existing energy efficiency

Figure 0—2 provides a summary of different fabric prevalence at the LSOA level in Westminster by the number of domestic buildings rather than percentage. It highlights denser areas requiring higher levels of fabric improvement, which may benefit from a coordinated effort.

Uninsulated solid walls are the dominant wall typology in Westminster. Due to the high number of listed buildings and the extend of conservation areas along with the disruption around external wall insulation (EWI) / internal wall insulation (IWI), the focus could around the more easily implementable measures such as unfilled cavity wall insulation, loft top-up and draught proofing, as they are less disruptive and more cost-effective with the potential to improve both energy efficiency and comfort.

Over 40% of properties in Westminster require an upgrade from single glazing, and more than 70% of the properties are in conservation areas. These properties can greatly benefit from upgrading single glazing. In most cases, the principle of installing new double glazing or triple glazing could be followed in listed buildings and conservation areas unless the property's windows contribute to its special external historic and architectural interest[20]. While glazing upgrades can be a rather expensive intervention, the energy saving they provide becomes more necessary with the heat pump roll-out, as it enhances the heat pump performance and addresses the potential noise issue associated with heat pumps. It also noticeably improves the properties' comfort levels.

Whilst individual fabric elements can be addressed separately retrofitting is most effective when taking a 'whole house' approach. There are a large number of properties flagged as requiring multiple fabric improvement measures. The North Paddington area is one area which would benefit from a whole house approach – including both fabric and heating system improvement. Due to the high density of mixed-use buildings and listed buildings in some areas (e.g., the Central area), fabric improvements would be challenging and require a customised approach. For instance, the Central area is largely under the ownership of Great Estates (Grosvenor, The Crown Estate, Portman Estate). This could, however, provide an opportunity for a coordinated effort to employ energy efficiency measures and low-carbon technology deployment.

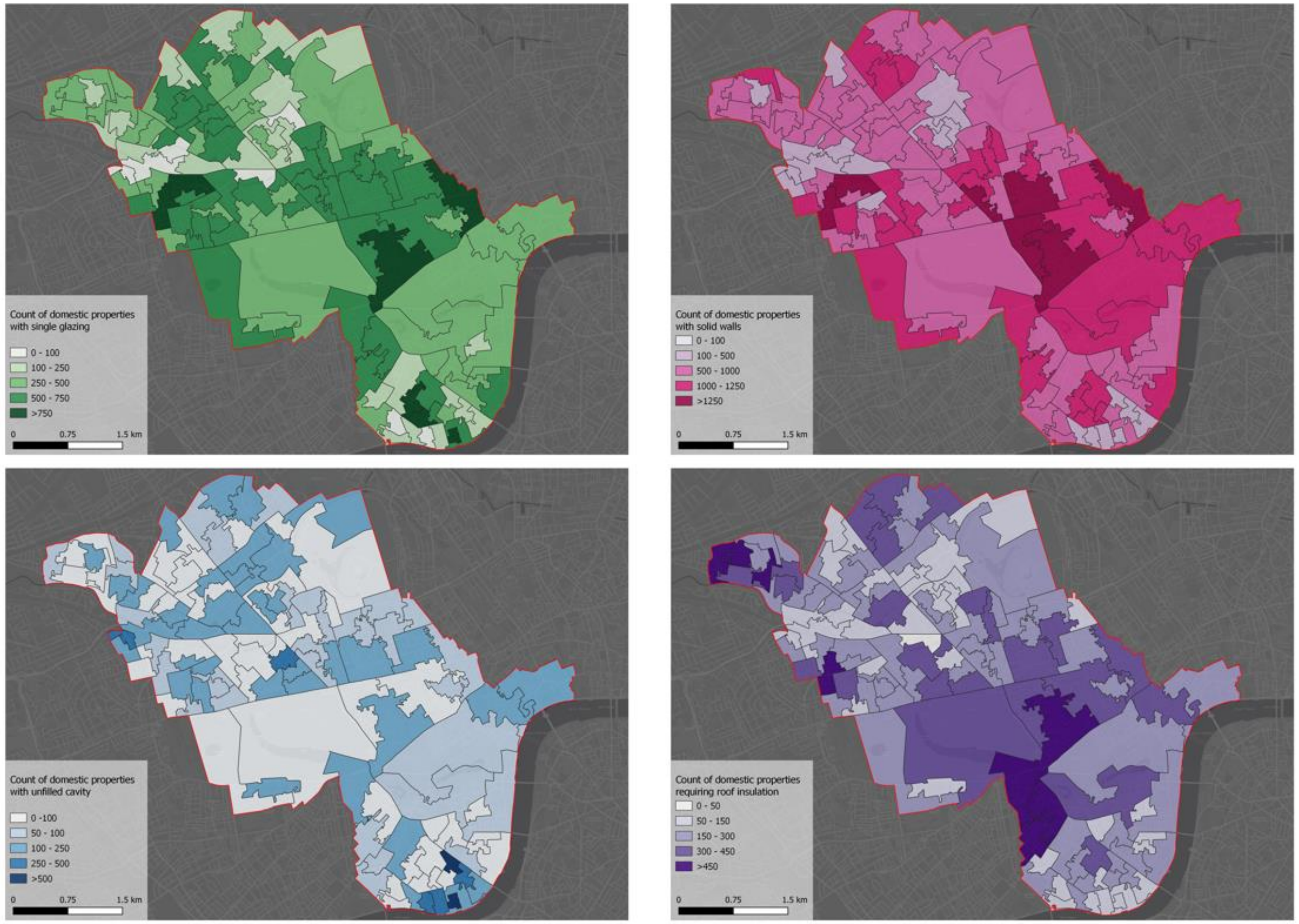


Figure 0—2 LSOA level count of uninsulated roof (top left), uninsulated solid walls (top right), single glazing (bottom left) and unfilled cavity walls (bottom right) in Westminster domestic properties

[20] In listed buildings if the existing windows contribute towards the special historic and architectural interest of that building, then alternatives to replacement, such as secondary glazing could be a better option. Westminster City Council, 2022, How to make your windows more energy efficient, See: https://www.westminster.gov.uk/media/document/windows-retrofit-how-to-guide

Domestic - Energy efficiency improvements

With above 60% of domestic properties having EPC D and below, Westminster could significantly benefit from fabric improvements through better insulation and improved airtightness. Retrofitting enhances buildings' energy efficiency by reducing energy demand, improving comfort, enabling smaller-sized heating systems, and improving the performance of low-carbon technologies such as heat pumps. Reduced heat demand could also reduce the need for grid reinforcement as a result of heat electrification.

Some of the possible building fabric improvements are listed in Table 0—2 along with their estimated retrofit cost and energy savings. Additionally, the table displays the count and share of each listed measure in Westminster. The energy savings and cost of retrofit for each individual measure can vary based on the building type and building floor area. For instance, the cost of solid wall insulation in a small, terraced house could be noticeably cheaper than a large, detached house. Moreover, regarding the potential energy saving, terraced houses could benefit less from wall insulation than detached houses.

Table 0—2 Potential retrofit measures descriptions, along with estimated cost and energy savings.

	Description	Retrofit cost per property [£]	Potential energy savings [%]	Count of properties in Westminster	Percentage of properties in Westminster [%]
Unfilled cavity wall insulation	Cavity wall is made up of two walls with an air gap in between before regulations required the gap to be insulated. The Cavity walls can be insulated by injecting the insulation material into the cavity. This is typically a low-cost and unintrusive retrofit intervention, making it an effective way to improve both energy efficiency and comfort.	380 – 1,400	4% - 14%	12,678	9.1
Solid wall insulation	Solid walls are made up of one or more layers of construction materials with less than 10mm gap in between. They can be insulated internally or externally. Internal wall insulation (IWI) is more intrusive as it requires moving the radiators, removing skirting boards and sockets and takes up from useful floor area, while the external wall insulation (EWI) is generally less disruptive than IWI, but it could be more expensive. Both present unintended consequences that need to be considered based on the wall construction. Solid wall insulation enhances energy efficiency and reduces draughts and noise.	4,400 – 18,000	9% - 18%	104,363	74.5
Glazing upgrade	Upgrading windows to new double/triple glazing or secondary glazing (conservation area and listing status dependent). This is a high-cost and moderately disruptive upgrade measure. Upgrading the windows could noticeably improve the comfort through better airtightness and improved thermal performance. Moreover, it also reduces the external noise.	2,700 – 12,200	5% - 7%	60,826	43.4
Roof and loft insulation	Adding an extra insulation layer could cut the heat losses through the roof. This is a low- disruptive and low-cost upgrade which reduce the energy demand with a noticeable comfort improvement.	350 - 960	5% - 17%	29,403	21.0
Draught proofing	Draught stripping is a low-cost and minimally disruptive measure that improves the comfort along with some energy saving.	80 - 360	2% - 3%	87,902 (The count of properties with EPC D or below)	62.7

The number of properties that would benefit from fabric energy efficiency improvements, as reflected in the data, underscores the scale of Westminster's challenge in improving its stock's energy efficiency. However, it is important to note that these figures do not imply each individual measure is needed or feasible for each property. Other factors such as EPC ratings, building type, the energy efficiency goal, and the required low-carbon heating system solution are also important in identifying feasible retrofit measures.

Due to the large number of old and historic buildings in Westminster, there is a high proportion of hard-to-treat building envelope types (e.g., the latest Energy Saving Trust (EST) research assumes that the majority of partially filled cavity walls have failed insulation and will therefore require internal wall insulation (IWI), rather than assuming the partially insulated cavities can be simply filled with additional insulation). Furthermore, properties within conservation areas and particularly listed buildings face additional constraints related to external wall insulation, window replacement, and the deployment of low-carbon technologies such as heat pumps and solar PV.

Table 0—3 and Table 0—4 provide insights into the total count of retrofit measures, the number of houses requiring retrofit, the potential energy savings and the cost of retrofit for all domestic properties and for WCC-owned properties, respectively and under two scenarios:

- High Ambition (aiming to maximise fabric improvement)
- Low Ambition (more focus on fabric improvement on least efficient properties)

Table 0—3 Overview of fabric improvement scenarios in Westminster

Scenario	Count of retrofit measures	Number of properties retrofitted	Energy savings (GWh/year)	Cost (m£)
High Ambition	226,544	117,509	166	1097
Low Ambition	52,593	21,656	51	233

Table 0—4 Overview of fabric improvement scenarios in domestic properties owned by Westminster

Scenario	Count of retrofit measures	Number of properties retrofitted	Energy savings (GWh/year)	Cost (m£)
High Ambition	34,352	18,888	19	129
Low Ambition	5,392	2,221	4	19

Domestic - Delivery scale review of energy efficiency improvements

A 100m grid spatial scale has been adopted to prioritise potential areas for fabric improvement, providing a finer resolution of the areas suitable for specific retrofit targeting. Multi factors are considered in identifying the prioritised areas, including the grid-level count of properties with E-G EPC ratings (Figure 0—3), the grid-level count of properties requiring different fabric upgrades, fuel poverty, WCC ownership data and shared ownership.

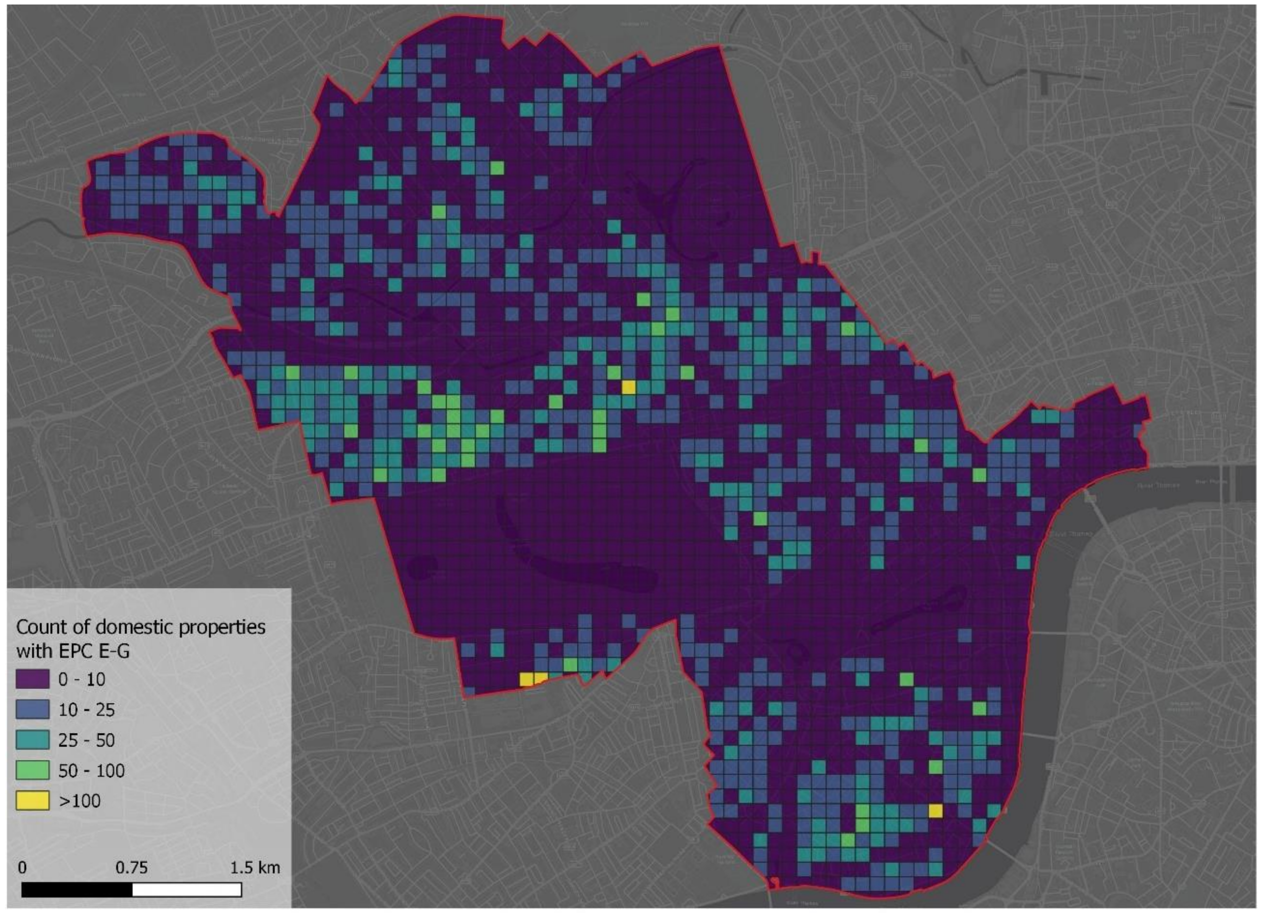


Figure 0—3 Grid level count of domestic properties with E-G EPC rating

Solid wall insulation priority areas

The priority areas for solid wall insulation are primarily informed by their EPC, count of solid walls and ownership data as presented in Figure 0—4.

Five solid wall insulation priority areas were identified in the analysis for early consideration and are outlined below:

The area in **Marylebone** is identified as suitable for solid wall insulation, with 800 properties falling within the EPC E-G range. The majority of the properties are under the Portman Estate ownership; this presents an initial opportunity to pursue a retrofit program in this area.

Some of the least energy-efficient properties are in this proposed initial opportunity area in **Lancaster Gate**. With over 1,400 properties falling under the E-G EPC band, the majority of the properties require more than one retrofit measure and could notably benefit from solid wall insulation.

In this proposed initial opportunity in **Vincent Square**, over 1600 WCC-owned, primarily low-rise flats, require solid wall insulation. Given the relatively high level of fuel poverty in certain parts of this area, fabric upgrades are deemed necessary. However, it is worth noting that the area is in the South Westminster Area Network (also known as SWAN) with an established decarbonisation strategy and a plan for heat network extension. Although, improving the fabric efficiency would improve both efficiency and comfort, the other projects identified could take precedence.

The **North Regent's Park** area encompasses approximately 2000 properties, mainly low-rise flats. The majority of these properties are requiring solid wall insulation, with over 500 properties being owned by WCC, there is an opportunity to initiate a retrofit program in the area.

The **Scott Ellis Garden** comprises over 400 WCC-owned low-rise flats; given the relatively high fuel poverty in this area, the properties notably benefit from undergoing solid wall insulation, leading to demand reduction and comfort improvement.

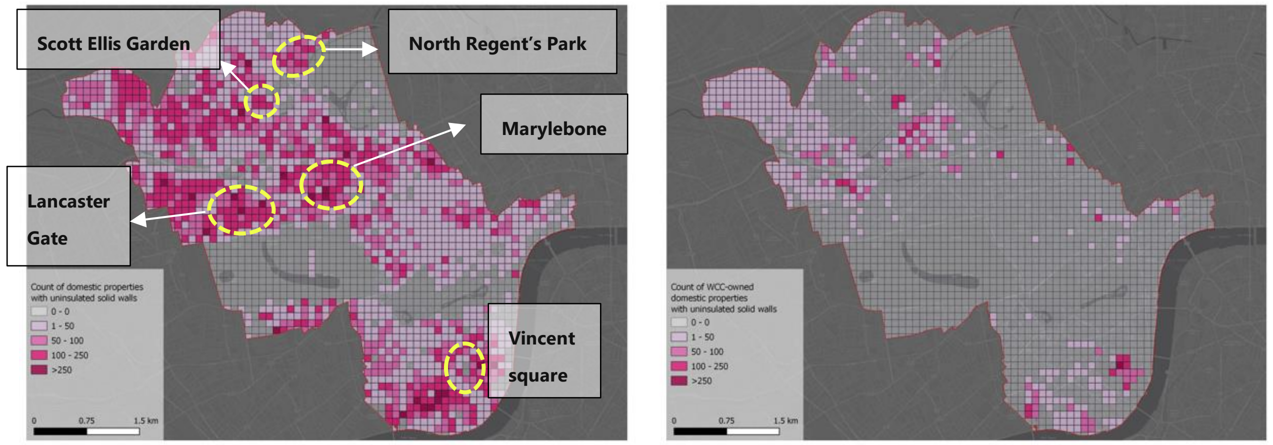


Figure 0—4 Grid level count of uninsulated solid walls in domestic properties in Westminster (left) and in WCC-owned properties (right)

Cavity wall insulation priority areas

The priority areas for cavity wall insulation are presented in Figure 0—5.

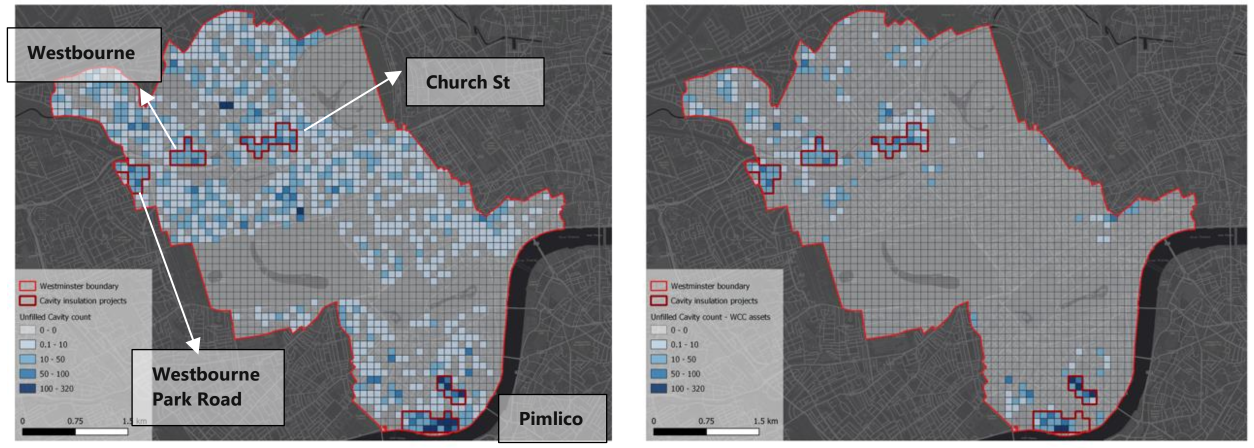


Figure 0—5 Grid level count of unfilled cavity walls in domestic properties in Westminster (left) and in WCC owned properties (right)

Four cavity wall insulation priority areas were identified in the analysis for early consideration and are outlined below:

The **Westbourne area** is primarily low-rise flats with high WCC ownership (~80%). About 40% of properties need cavity wall insulation. Given the relatively high fuel poverty level in this area, the properties could highly benefit from demand reduction and comfort improvement through fabric retrofit.

The **Westbourne Park Road** area is dominated by low-rise flats and high WCC ownership (~70%). Almost half the properties require cavity wall insulation. High share of WCC ownership could accelerate the fabric retrofit program in the area.

The **Church Street** area is primarily low-rise flat with rather high WCC ownership (~60%). About 40% of council-owned properties need cavity wall insulation. Given the relatively high fuel poverty level in this area, the properties could benefit from demand reduction through fabric improvement.

The **Pimlico North** area consists of around 900 WCC owned properties with majority 70% cavity wall insulation (~70%). However, there is large number of listed buildings in the area which could present challenge to retrofit. Similarly, the **Pimlico South** is a large area with high density of flats cavity wall insulation. About 50% of the properties are owned by WCC.

Roof insulation and loft top-up priority areas

The priority areas for roof insulation and loft top-up are presented in Figure 0—6.

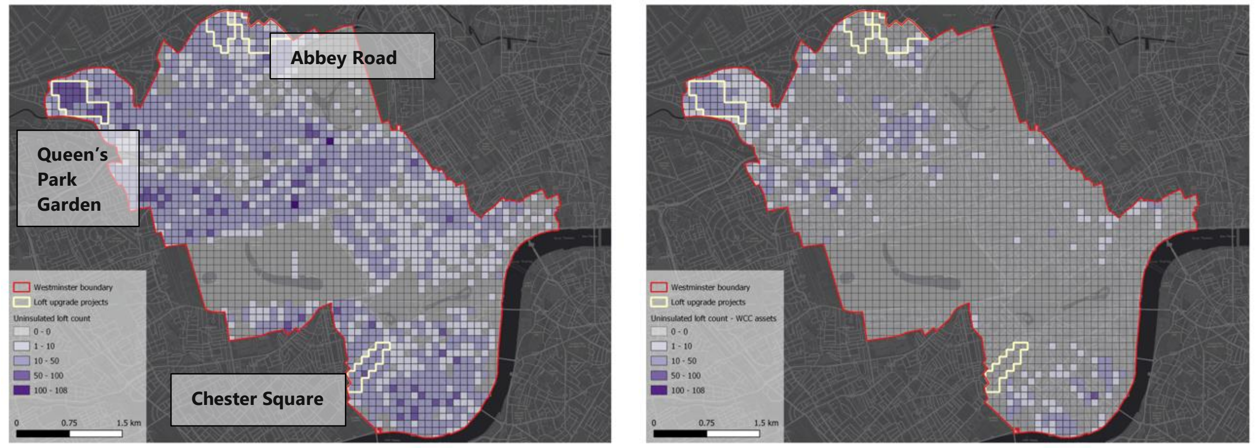


Figure 0—6 Grid level count of uninsulated roofs in domestic properties in Westminster (left) and in WCC owned properties (right)

Three solid wall insulation priority areas were identified in the analysis for early consideration and are outlined below:

The **Queen's Park Garden** has a large share of terrace houses and WCC ownership, with 70% of properties requiring loft top-up. In addition to the noticeable comfort improvement, a loft upgrade could enhance the heat pump performance if a heat pump rollout happens in the area. The area is also located in the North Paddington Programme.

The **Abbey Road** area is dominated by private detached/semi-detached properties, with about 75% of them requiring loft top-up. This low-cost, low-disruption intervention could also improve the heat pump performance if a heat pump rollout happens in the area.

The **Chester Square** area has a large number of privately owned terrace houses and low-rise flats, where about 65% of properties need a loft top. The area has also been identified as suitable for heat pump rollout.

The priority areas for single glazing upgrade are presented in Figure 0—7.

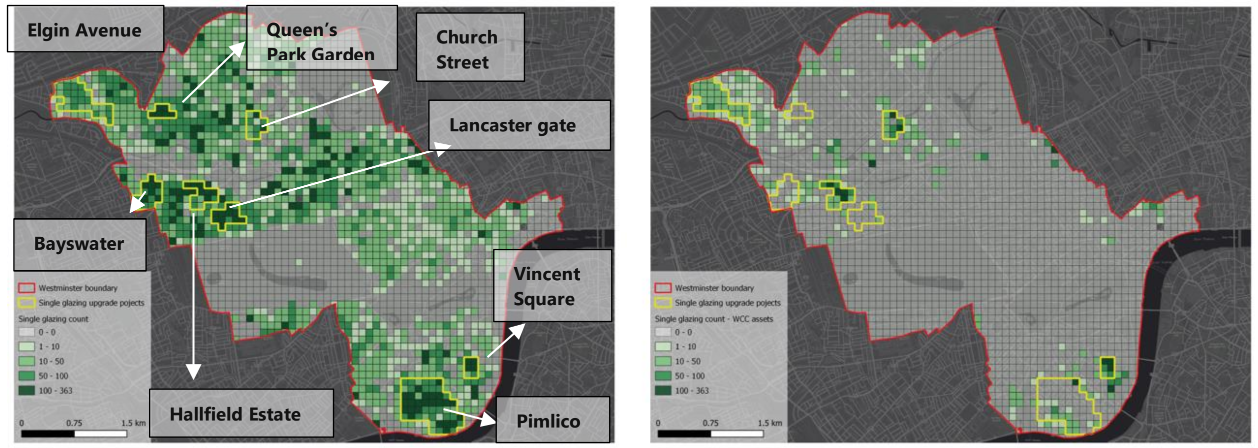


Figure 0—7 Grid level count of single glazing in domestic properties in Westminster (left) and in WCC owned properties (right)

An overview of the single-glazing priority areas, identified as early areas to consider in the analysis is provided below:

Glazing upgrade is required in 70% of WCC owned properties **in Queen's Park Garden** area. With large share of terrace houses and WCC ownership, the area has been identified suitable for HP deployment, and improving the fabric efficiency could improve heat pump performance and efficiency. The area is also located in North Paddington Program.

The **Bayswater** area mainly includes private-owned low-rise flats and terrace house, where about 60% of properties having single glazing. The area is also identified suitable for heat pump rollout and upgrading windows would enhance the heat pump performance.

The area **Elgin Avenue** comprises about 900 old flats (mainly built 1900-1929) mostly private owned and 80% of properties needs glazing upgrade.

The **Church Street** area is largely dominated by WCC-owned flats (~750) where around 75% requiring a glazing upgrade. The area has a high fuel poverty level, and the properties could highly benefit from demand reduction through fabric improvement.

Private-owned flat dominated in **Lancaster Gate** area, where above 70% of properties need glazing upgrade. About 12% of properties are listed. However, the private ownership introduces complexities for fabric retrofit initiatives in the area.

WCC-owned flats dominated area (~1000) in **Vincent Square** area where around 70% requiring a glazing upgrade, proves to be a suitable area for scale roll out of glazing upgrade.

The **Pimlico** area includes high density of flats with generally poor fabric and the properties could hugely benefit from glazing upgrade through both demand reduction and comfort improvement. However, it is also worth noting that as the area is in South Westminster Area Network (also known as SWAN) with an established decarbonisation strategy and a plan for heat network extension. Although, improving the fabric efficiency is necessary, the other projects identified could take precedence.

Non-domestic buildings retrofit

Non-domestic - Existing fabric

The following maps (Figure 0—8) provide an LSOA-level summary of the percentage of non-domestic properties with an E-G energy band and share of different building fabric makeups, including uninsulated solid walls, unfilled cavity walls and single glazing in Westminster.

It should be noted that the non-domestic dataset does not provide any fabric information. As such, the fabric of non-domestic properties has been estimated based on the fabric of domestic properties in their proximity. Given the high levels of uncertainty regarding the fabric data in non-domestic properties, the general indications for poor performance areas is mostly led by energy ratings (EPC).

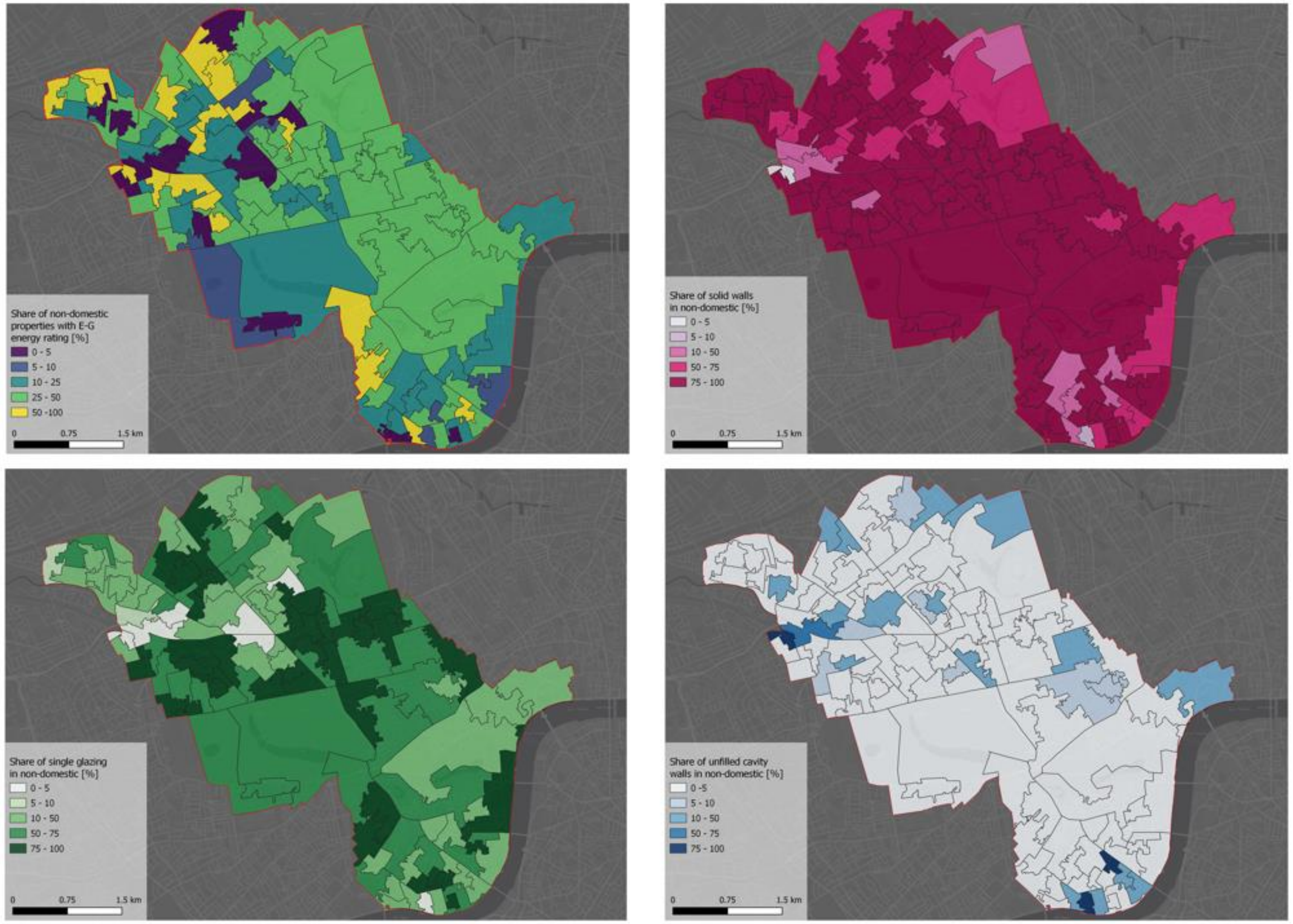


Figure 0—8 LSOA level data regarding the percentage of: Top left: non-domestic properties with E-G energy band, Top right: non-domestic properties with solid walls, bottom left: non-domestic properties with single glazing, bottom right: non-domestic properties with unfilled cavity walls

Non-domestic - Strategic scale review of existing energy efficiency

A summary of the grid-level, non-domestic properties with energy ratings E-G and fabric estimates per makeup category is presented in Figure 0—9. The figures underscore the scale of poor energy performance in the area and the need for improvements. The high density of listed buildings contributes to the challenge of energy efficiency improvement in this area. However, given that the area is largely under the Great Estates ownership (Grosvenor, The Crown Estate, Portman Estate, Howard de Walden), there is potential scope for a coordinated effort to deploy energy efficiency measures and low-carbon technologies.

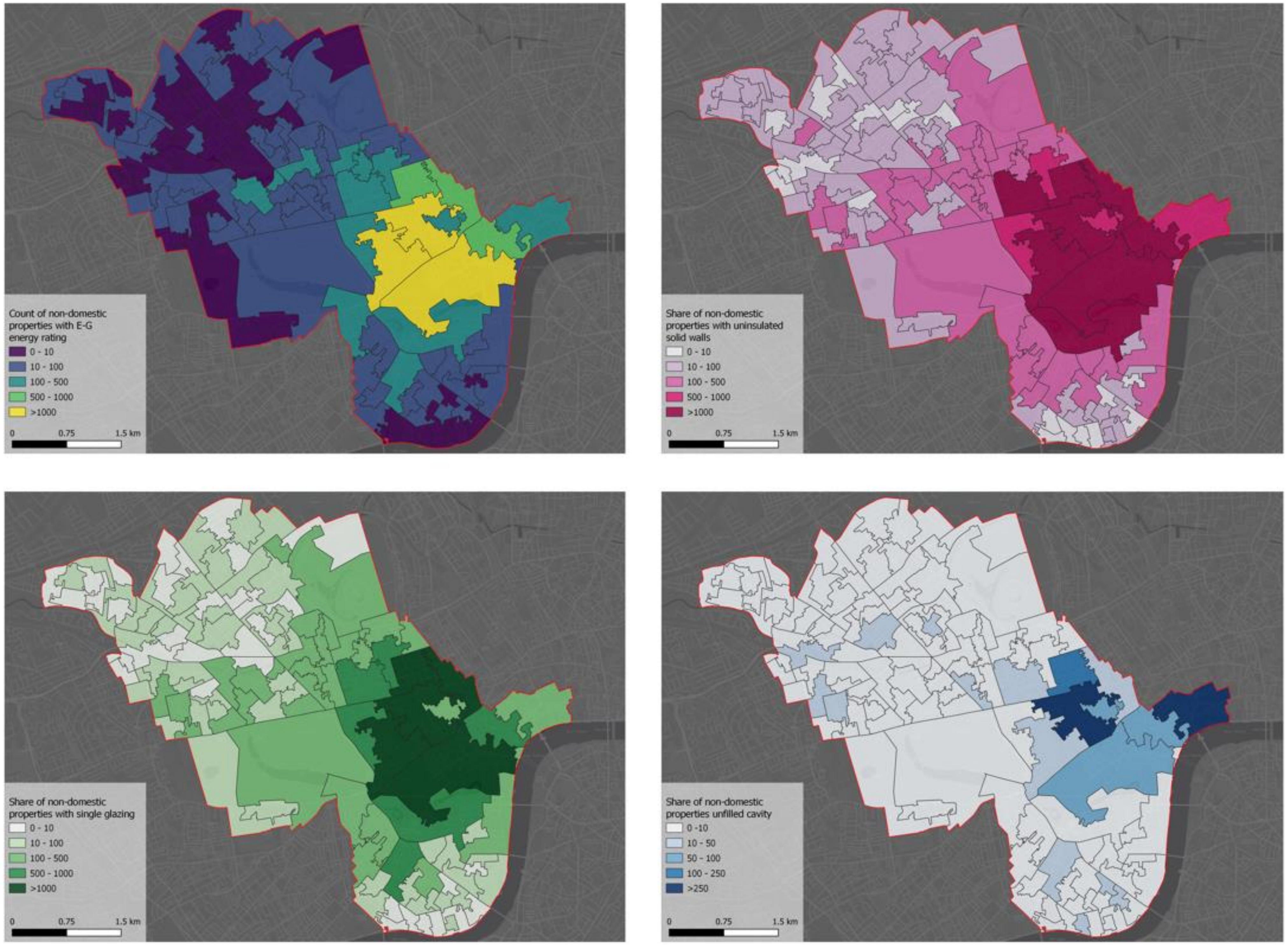


Figure 0—9 LSOA level data regarding the count of: Top left: non-domestic properties under E-G energy band, Top right: non-domestic properties with solid walls, bottom left: non-domestic properties with single glazing, bottom right: non-domestic properties with unfilled cavity walls.

Non-domestic - Energy efficiency improvements

As previously presented, from the over 37,500 non-domestic properties in Westminster, more than 60% have EPC of D or below (29% EPC D and 32% EPC E-G). This confirms a great potential for fabric improvement and reduction in energy demands in Westminster. However, there is a high level of uncertainty around the fabric data in non-domestic properties, and the general indication of the poor performance area is mainly guided by energy ratings with a focus on properties rated E-G.

Table 0—5 provides statistics regarding the fabric in non-domestic properties, mainly estimated from the domestic properties' fabric in the nearby domestic properties (due to data quality). For the non-domestic analysis, the cost of fabric upgrades is provided in £/m2. This represents the wall area in the case of wall insulation and the window area in the case of glazing upgrades[21].

Table 0—5 Potential retrofit measures with estimated cost and energy savings

	Energy Saving	Cost [£/m2]	Count of properties in Westminster	Percentage [%]	Count of properties with E-G energy ratings
Solid wall insulation (EWI and IWI)	12%-15%	126 - 220.5	31,924	85%	10,620
Unfilled Cavity wall insulation	10%	5.67	1,756	4.6%	448
Single glazing upgrade	5.5%	580	23,265	62%	8,004

Over 84% of the non-domestic properties in Westminster are in conservation areas, and 19% are listed, which may restrict energy retrofit depending on conservation area planning requirements. These constraints are factored into the fabric upgrade scenarios. For instance, for a Grade I listed building, solid wall insulation is excluded, regardless of the building's energy ratings.

Table 0—6 provides an overview of the fabric upgrade analysis in non-domestic properties under two scenarios:

High ambition scenario, aiming to maximise fabric improvement

Low ambition scenarios where the fabric improvement is primarily driven by properties with E-G energy ratings and focusing on the lowest energy performance properties

Table 0—6 Overview of fabric improvement scenarios in non-domestic properties in Westminster

	Count of retrofit measures	Number of properties retrofitted	Energy savings (GWh/year)	Cost (£ millions)
High Ambition	50,709	30,191	364	2,260
Low Ambition	21,871	11,770	147	697

Of the approximately 759 non-domestic properties owned by WCC, 176 of them have E-G energy ratings. Table 0—7 provides insights into the fabric upgrade analysis of WCC assets. It is worth noting that although WCC owns about 2% of non-domestic properties, its share of overall heat demand is 5%. This is attributed to several high-demand properties including schools, leisure centres, museums, and art galleries under WCC ownership[22].

Table 0—7 Overview of fabric improvement scenarios in non-domestic properties owned by WCC

	Count of retrofit measures	Number of properties retrofitted	Energy savings (GWh/year)	Cost (£ millions)
High Ambition	886	536	20.4	37.4
Low Ambition	324	172	13.4	13.6

[21] It is assumed that the wall area is 40% of the floor area, and the window area is estimated to be 60% of the wall area.

[22] It should be noted this is based on land ownership and is thus different to the building being owned and operated by WCC.

Non-domestic – Delivery scale review of energy efficiency improvements

A 100m grid spatial scale has been employed to prioritise potential areas for energy efficiency improvement. Several factors have been considered in identifying the prioritised areas, including the grid-level count of properties with E-G EPC ratings and the grid-level count of properties requiring fabric upgrades (Figure 0—10), the potential energy saving that can be achieved through retrofit (Figure 0—11), the WCC ownership or having similar ownership (e.g., properties owned by Great Estates).

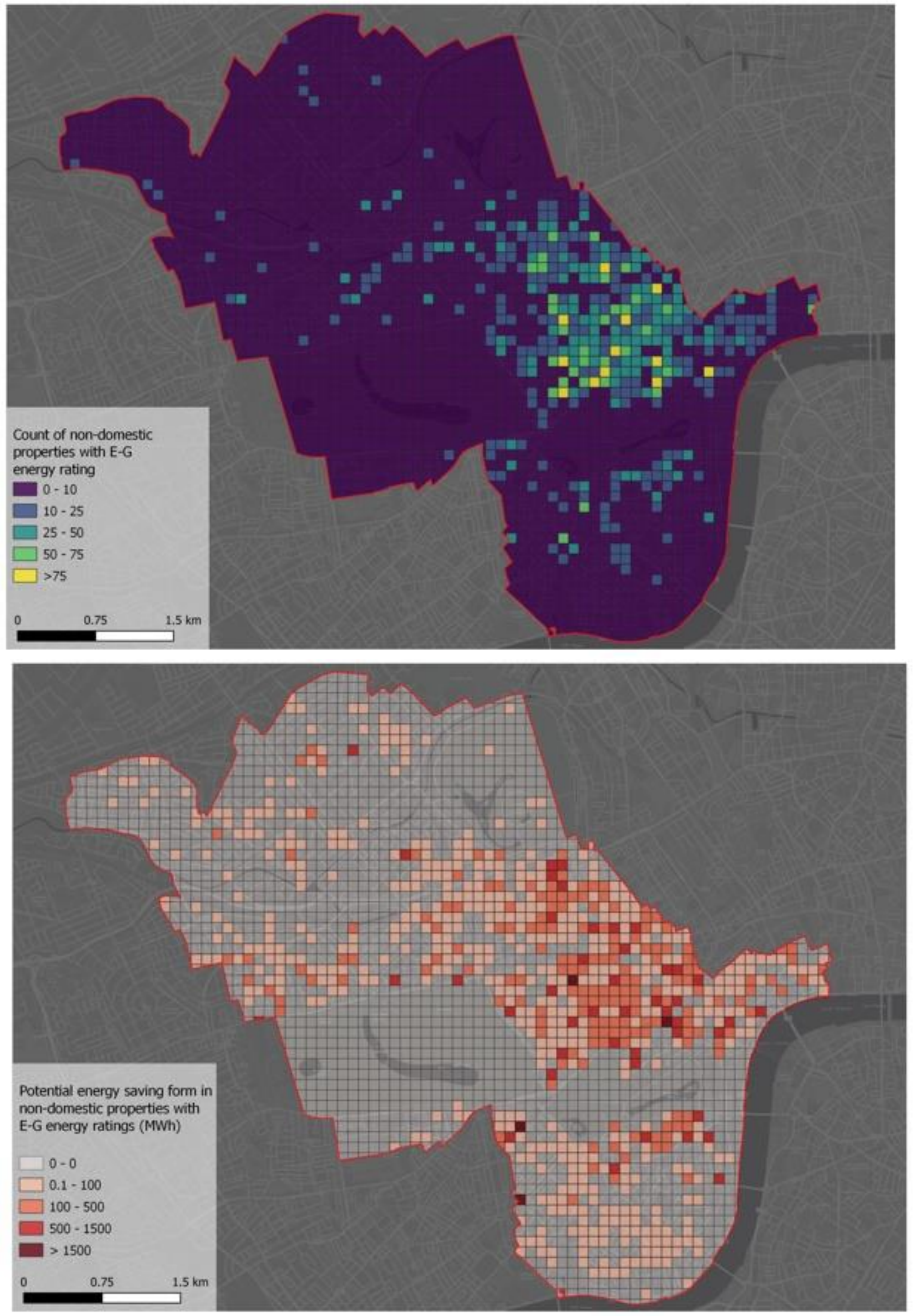


Figure 0—10 100m grid level count of non-domestic properties with E-G energy ratings (left) and the potential energy saving through retorit in non-domestic properties with E-G energy ratings

Figure 0—11 provides and overview of the priority areas for fabric improvement in non-domestic properties.

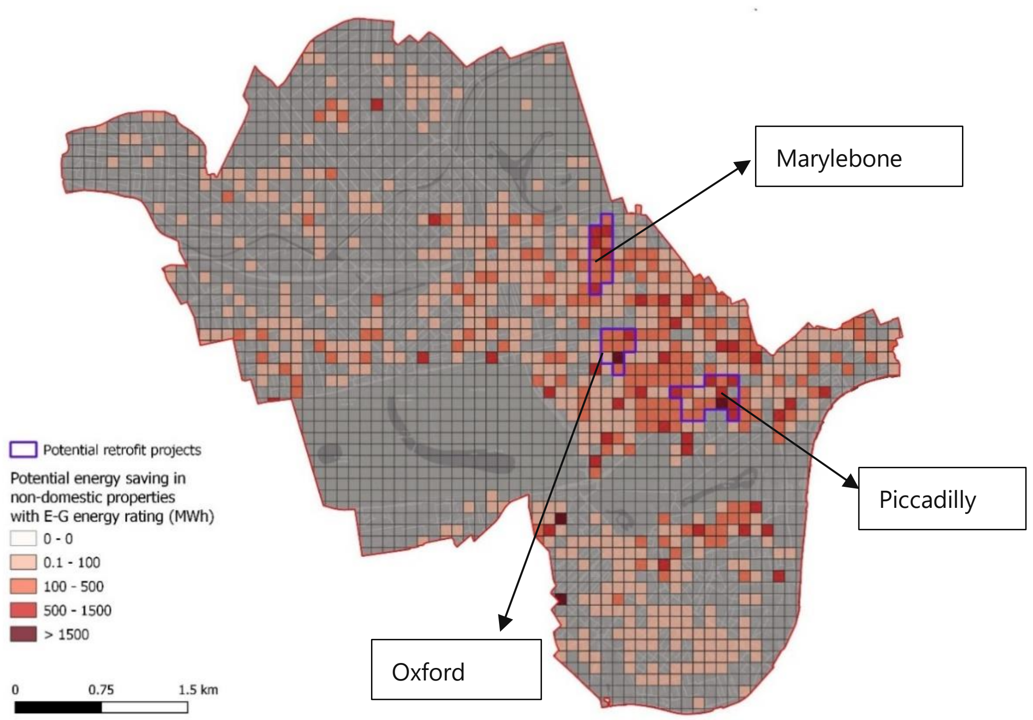


Figure 0—11 Overview of prioritised area for potential retrofit projects in non-domestic sector

Three priority areas were identified in the analysis for early consideration and are outlined below:

- Easy to retrofit non-domestic buildings within the **Piccadilly** area can save approximately 7 GWh. This encompasses over 400 offices, primarily owned by The Crown Estate. Having similar ownership structures could accelerate the implementation of these retrofits. Notably, a significant portion of this area falls within the boundary of the Heart of London Business Alliance.
- There are retrofit opportunities in non-domestic buildings in the **Marylebone** area, with the potential for 4.6 GWh in energy savings achievable through glazing upgrades and cavity wall insulation. These buildings are situated within the Howard De Walden Estate, and shared ownership within this estate could accelerate the retrofit process. Furthermore, the proposed area is positioned within the Harley Street Business Improvement District.
- Another priority area for energy efficiency improvement is in the **Oxford Street area**, including over 300 offices and the potential for substantial energy saving above 5.5 GWh in properties with E-G energy ratings.

Heating and Cooling

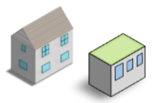
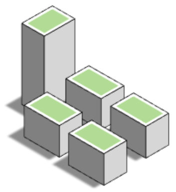
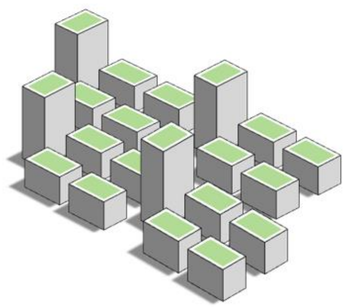
Introduction

This section focusses on a review of the heating and cooling delivery options for the properties across Westminster. Depending on a number of factors including the density of heat demand and the building typology a variety of heating system solutions are available to Westminster. This section aims to identify the most likely solution in each location for decarbonised heat supply to the buildings.

Heating typologies

The largest and most challenging aspect of the current energy system in Westminster to transition is the way in which buildings are heated. Four different scales of heating system solution are considered in this LAEP, these are summarised in Table 0—1. Understanding these different solutions helps to give context to the current heating systems in place.

Table 0—1 Summary of different heating system scales and solutions considered for Westminster.

Heating system solution	Building(s) type	Usual context for deployment
Single heat pump		Generally, for if the building contains just one or a few small properties, has a relatively small heat demand (e.g. a house or standalone commercial property). Demand will be under 100 MWh/yr, otherwise communal or heat network is considered.
Communal system (generally from one centralised solution – e.g., heat pump)		Building that contains multiple properties (e.g. flats). Larger buildings with communal systems will often be identified for connection into a wider heat network. In some datasets these can be hard to distinguish from small scale heat networks.
Small scale heat networks		These heat networks are relatively small connecting a few geographically close buildings, for example a block.
District heat network		Generally, areas with high heat density and/or proximity to waste heat sources and/or areas with growing number of planned new development are suitable for heat network. For listed buildings, planning permission for heat pump installations could be challenging, making heat network more suitable option. Buildings over 100MWh/yr will potentially be mandated to connect (unless demonstrated unviable) if within a heat network zone under current plans in the Department of Energy Security and Net Zero.

The need for a distinction between district heat networks, small scale heat networks and communal systems was highlighted in stakeholder workshops. The large number of buildings which contain multiple properties in Westminster meant a very high proportion of communal systems were identified. The two scales of heat networks are normally referred to together in this report as heat networks, as it is difficult to make a distinction without a more detailed feasibility study. However, it is important to note that not all buildings will be connected to a large-scale solution connecting tens or hundreds of buildings.

To achieve net zero, properties with fossil fuel heating system require upgrading to low/zero carbon heating solutions. For the properties connecting to a gas-supplied heat network/communal heating system, there is no need for property level changes (in most cases) instead the heat supply system needs replacement with a low/zero carbon alternative.

In all cases, the route to decarbonisation of heat is most likely to be electrification of heat. This is typically via the introduction of heat pumps which can be provided at a single dwelling scale through to city scale systems. The advantages of heat networks are that a variety of heat sources (including waste heat from data centres, transformers and other sources) can be interconnected into a single network, potentially providing a more efficient system and lower cost of heat to consumers.

Replacing fossil fuel systems with direct electric systems is not favoured in the scenario modelling. This is due to the relative inefficiency of direct electric compared to heat pumps, i.e. direct electric requires ~2.8 times the electricity to provide the same heat as a heat pump. Given that electricity is currently nearly 4 times the price of gas for domestic consumers (although this does improve in later years in the modelling) this means that direct electric solutions would increase fuel bills compared to a fossil fuel system. Consequently, such a switch would be hard to justify to consumers and could increase issues like fuel poverty that an LAEP should seek to reduce. As such heat pumps are preferred to direct electric solutions. It should be noted in some specific cases it should be noted that direct electric may be the only viable zero carbon solution, but such relatively infrequent situations are not a focus of the LAEP.

Westminster heating context

The ~140,000 domestic properties and ~37,500 non-domestic properties in Westminster require approximately 3,990 GWh annual heating demand covering both space heating and hot water. As Figure 0—1 shows, above 66% of heat demand is met by natural gas through either the gas network, heat networks or communal heating systems. The total gas consumption is about 3,273 GWh and the total electricity consumption is 3,027 GWh annually. Approximately 40% of the electricity usage in Westminster is for heating/cooling and the remaining is for other electrical usage including ventilation, lighting and small power.

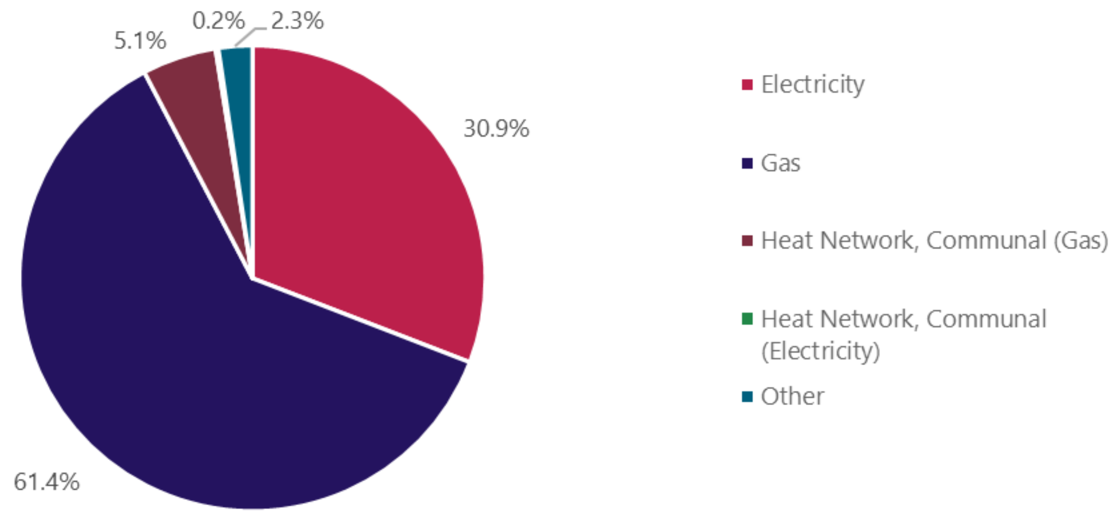


Figure 0—1 Share of heat demand by heat source in Westminster

Approximately 23% of heat demand is from domestic properties, while offices account for the majority of heat consumption in Westminster (~34%). Figure 0—2 presents the distribution of heat demand among different typologies in Westminster.

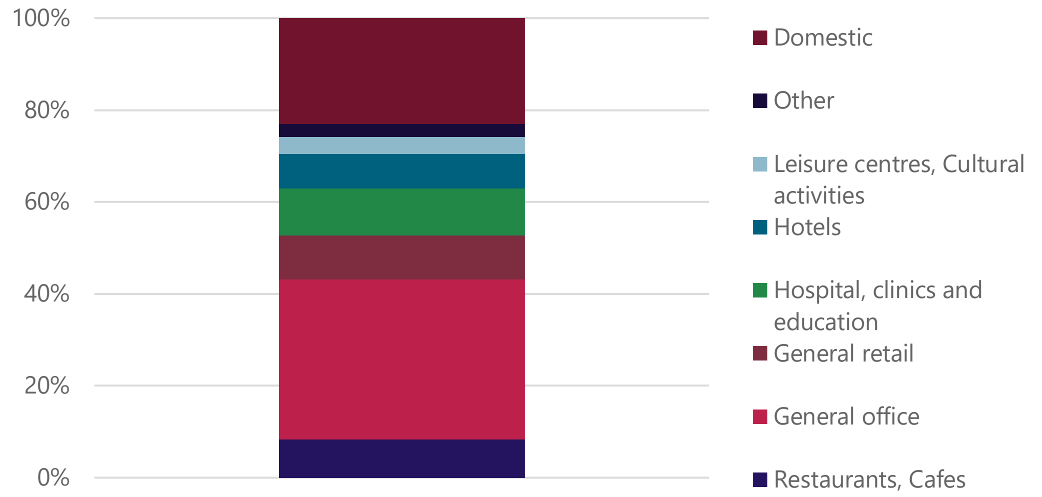
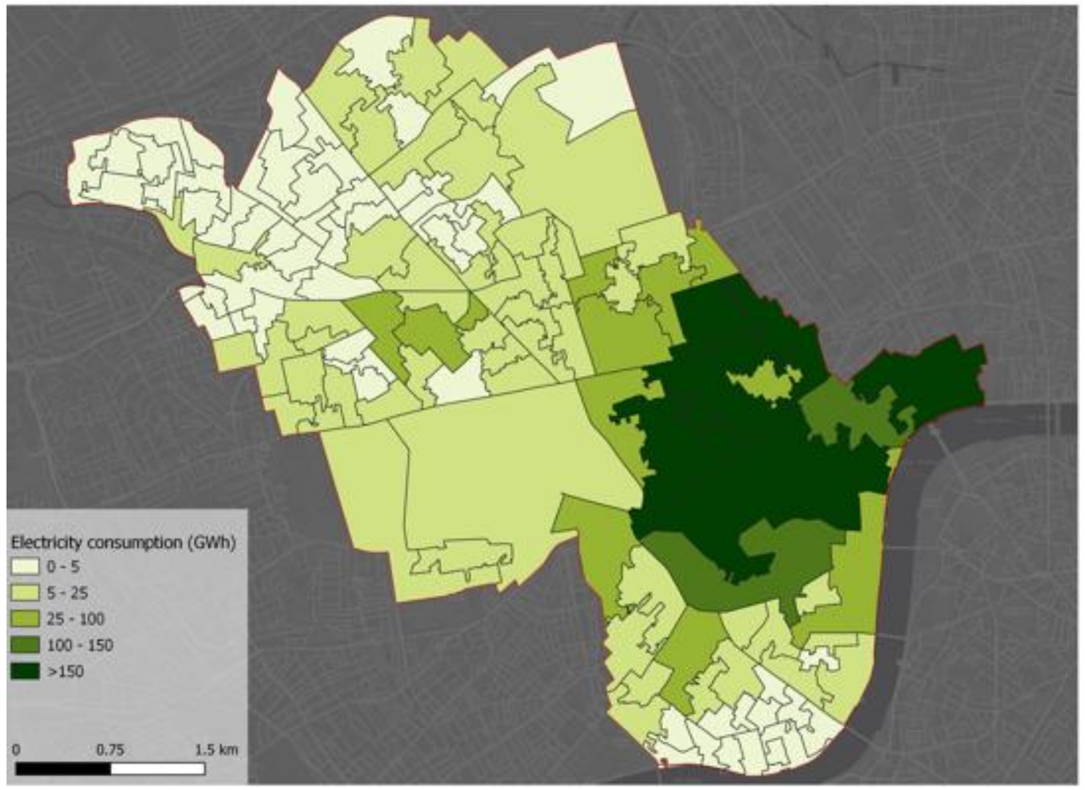


Figure 0—2 Distribution of heat demand by typology

Figure 0—3 shows the gas and electricity consumption per LSOA in Westminster. As shown, the central east area has the largest heat and gas consumption. This is a very dense area with large number of commercial and public buildings, such as offices, retails, museums, and theatres.



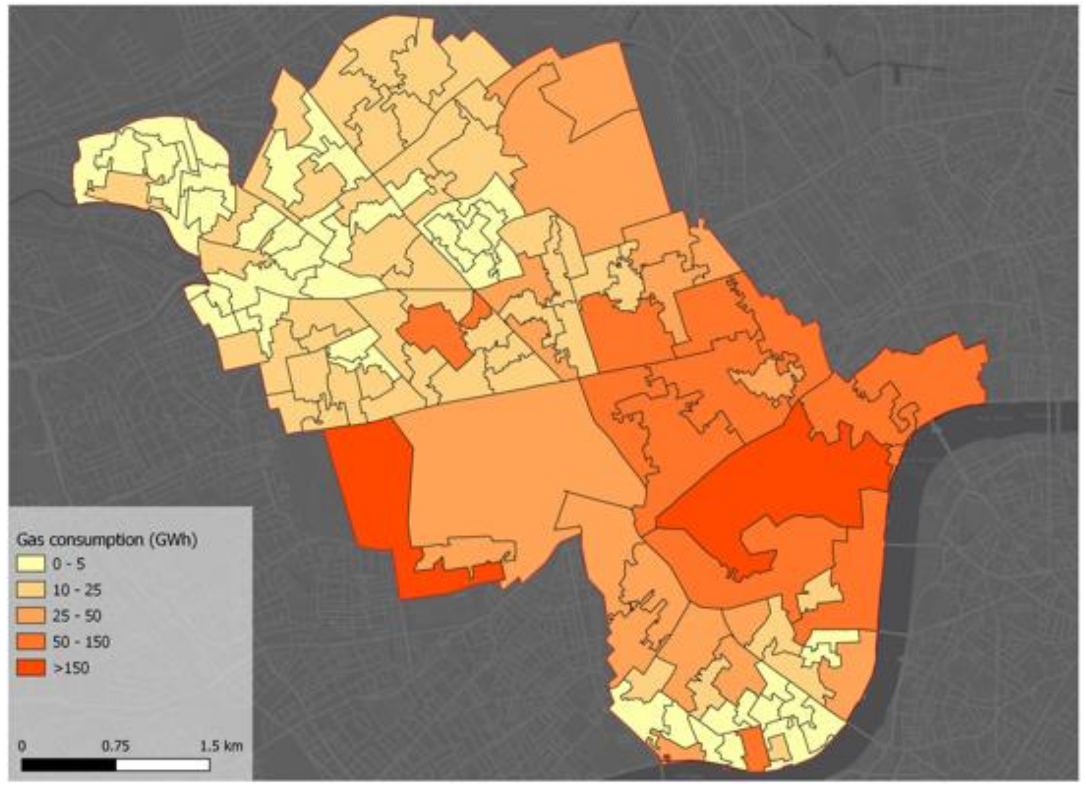


Figure 0—3 Electricity (top) and gas (bottom) consumptions per LSOA in Westminster

Domestic heating systems

Approximately 83% of the domestic properties in Westminster use natural gas for their hot water and heating supply either directly through the main gas network or through a gas-supplied heat network/communal heating system.

The primary heating system for 61% of domestic properties is gas boilers, followed by 22% with natural gas-supplied heat network/communal heating, and 12% with direct electric or electric storage heating systems (see Figure 0—4). Only a minority are currently heated with lower carbon heat pump led systems.

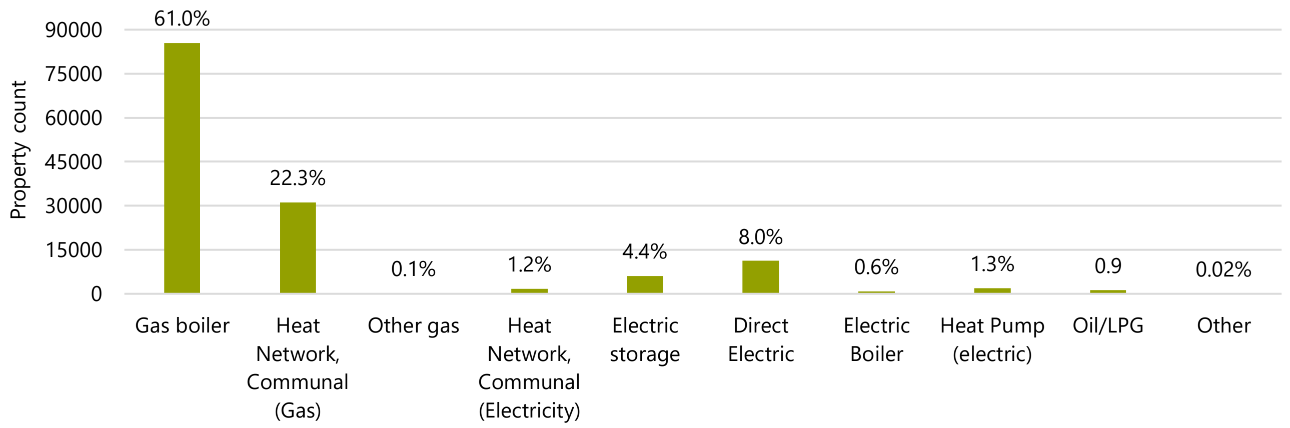


Figure 0—4 Count of domestic properties by primary heating system

There is an annual heat demand of ~918 GWh in the domestic stock in Westminster and natural gas supplies more than 84% of that. This accounts for the heat supplied through main gas network or through gas-supplied heat network/communal heating system. Figure 0—5 provides the breakdown of heat demand by the heat source.

Approximately 13% of heat demand in domestic properties is met by electric heating systems, while heat pump contributes only 1.5% to the heat demand in domestic properties (~11GWh annually).

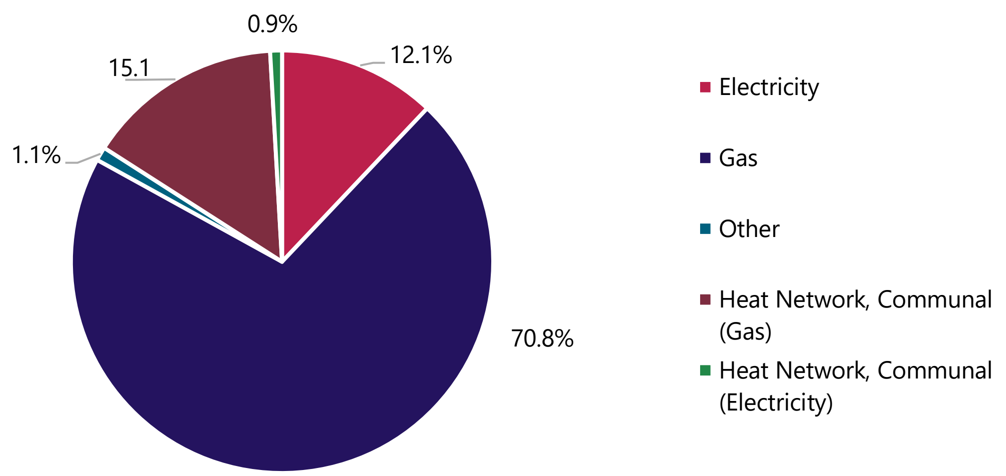


Figure 0—5 Breakdown of heat consumption in domestic properties by the heat source

The total annual gas consumption in domestic properties is circa 945 GWh (2021/22 data); Figure 0—6 shows the gas consumption in domestic properties at LSOA level. The highest overall domestic consumption is in the West End (central) and Abbey Road (north) ward areas.

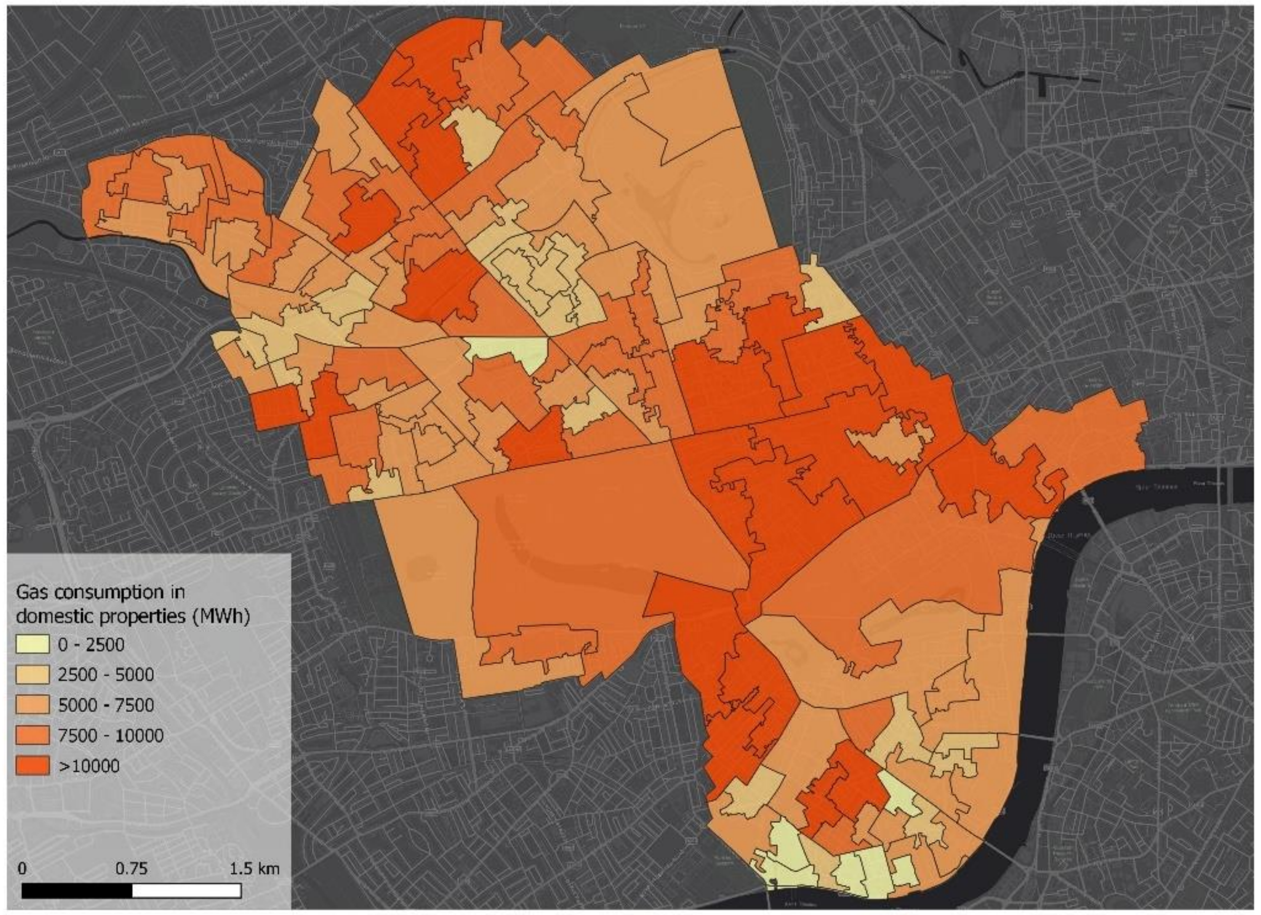


Figure 0—6 Gas consumption in domestic properties by LSOA in Westminster

Figure 0—7 shows the current count of domestic properties with electrified heating system in Westminster. This includes heat pumps, electric boiler, direct electric/storage heaters, electricity-supplied communal/heat network system.

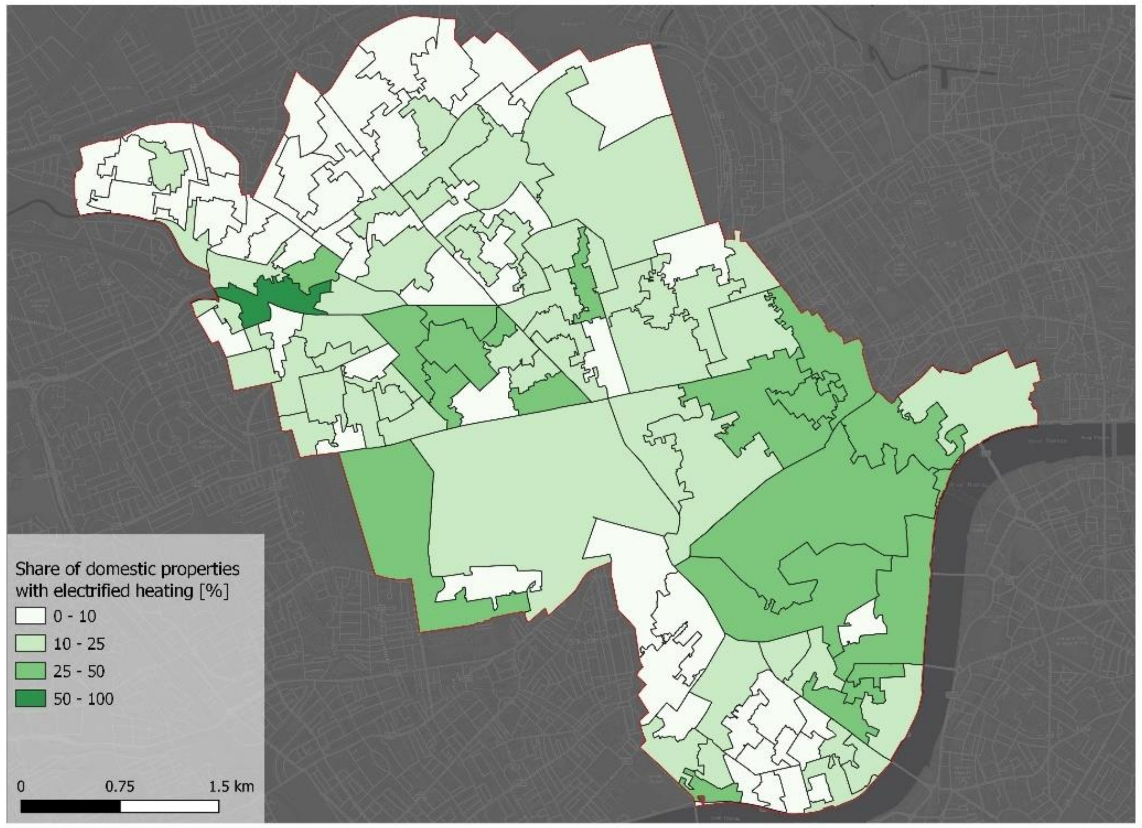


Figure 0—7 Count of domestic properties with a form of electric heating in Westminster at LSOA level

Non-domestic heating systems

Over 67% of non-domestic properties in Westminster primarily use electricity as for their heating, while approximately 30% use gas for heating as shown in Figure 0—8. These gas heated properties are a priority for heating decarbonisation.

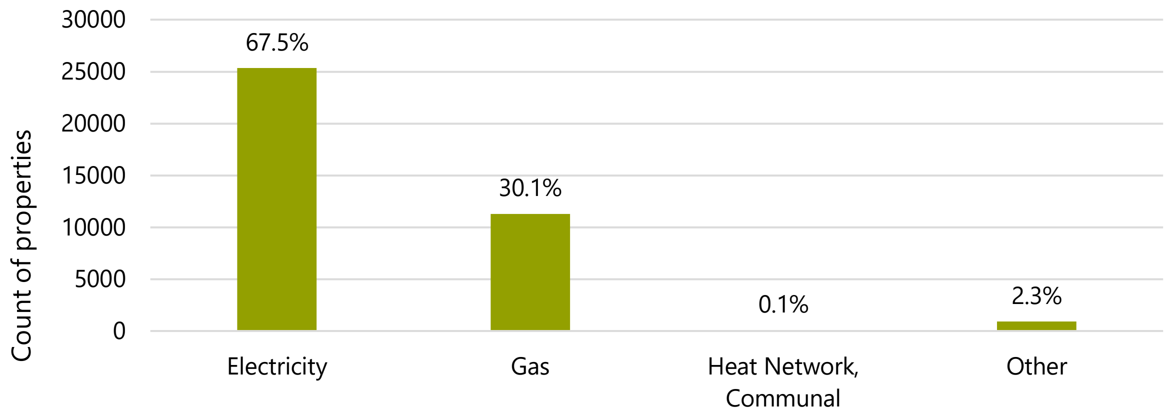


Figure 0—8 Count of non-domestic properties by primary heating system

Although this is the minority in terms of heating system count, when considering the actual heat demand (Figure 0—9), gas-supplied heating system contributes to 58% of total heat demand of 3070 GWh annual heat demand in Westminster. This is due to the lower efficiency of gas supplied heating compared to electric heating. Moreover, although the count of gas-heated properties is lower, some of the larger consumers / overall floor area of the buildings in in Westminster are typically gas heated. The gas heated buildings constitute circa 52% of the total non-domestic floor area in Westminster.

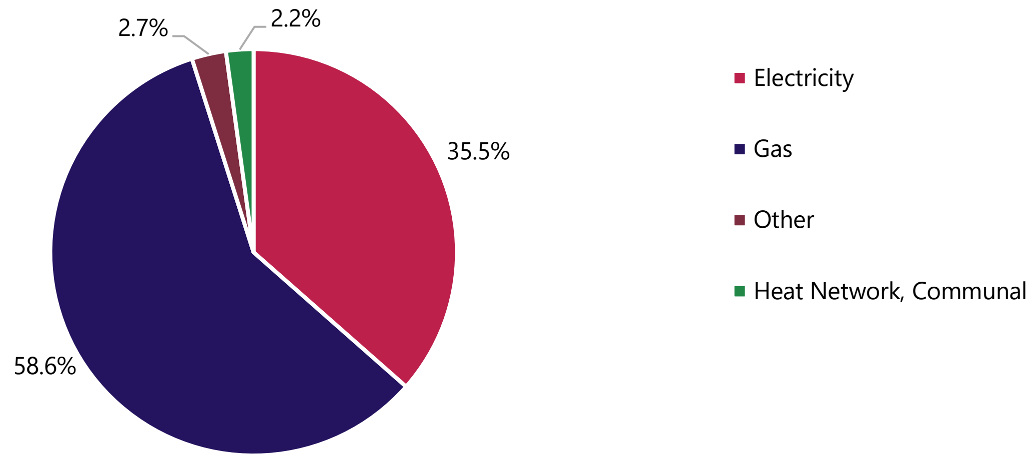


Figure 0—9 Share of heat demand by heat source in non-domestic properties

Figure 0—10 provides the breakdown of heat demand by the heat sources and by typologies in Westminster. Approximately e 45% of the demand is utilised in offices, as expected.

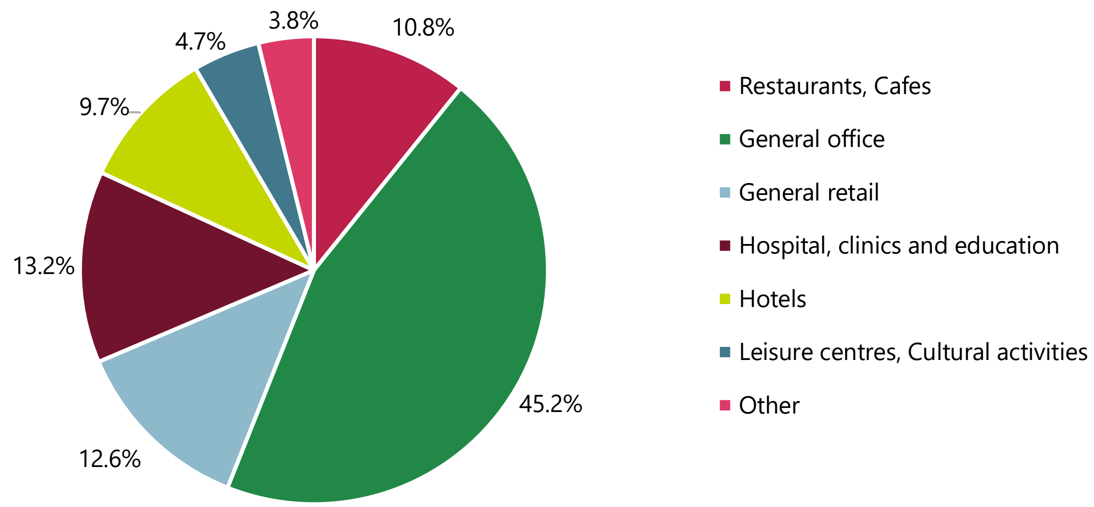


Figure 0—10 share of heat demand by typology in non-domestic properties

The total annual (2021/22 data) gas and electricity consumptions in non-domestic properties are about 2327 GWh and 2558 GWh respectively. It is worth noting that 44% of the electricity usage is for heating and the remaining is for other electrical usage including ventilation, lighting, small power, etc. Figure 0—11 and Figure 0—12 present the gas and electricity consumptions in non-domestic properties at LSOA level.

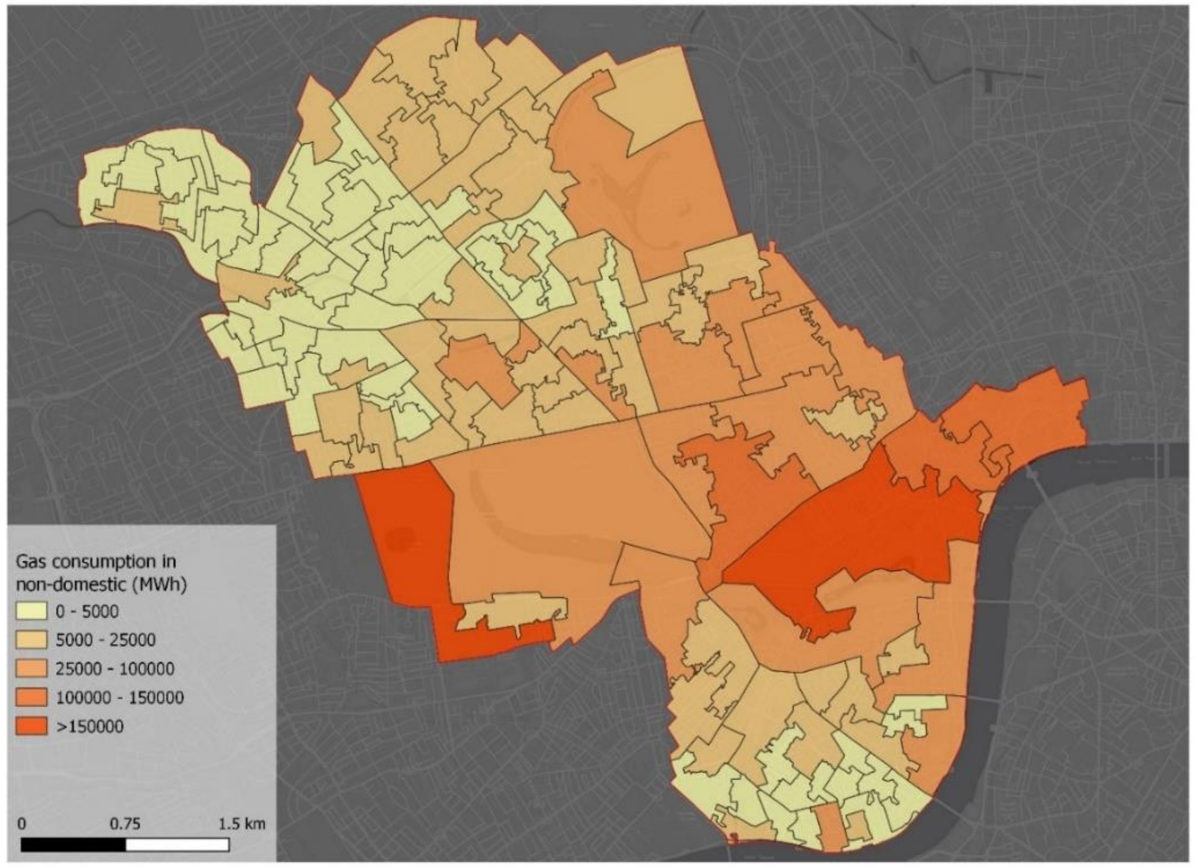


Figure 0—11 Gas consumption in non-domestic properties by LSOA in Westminster

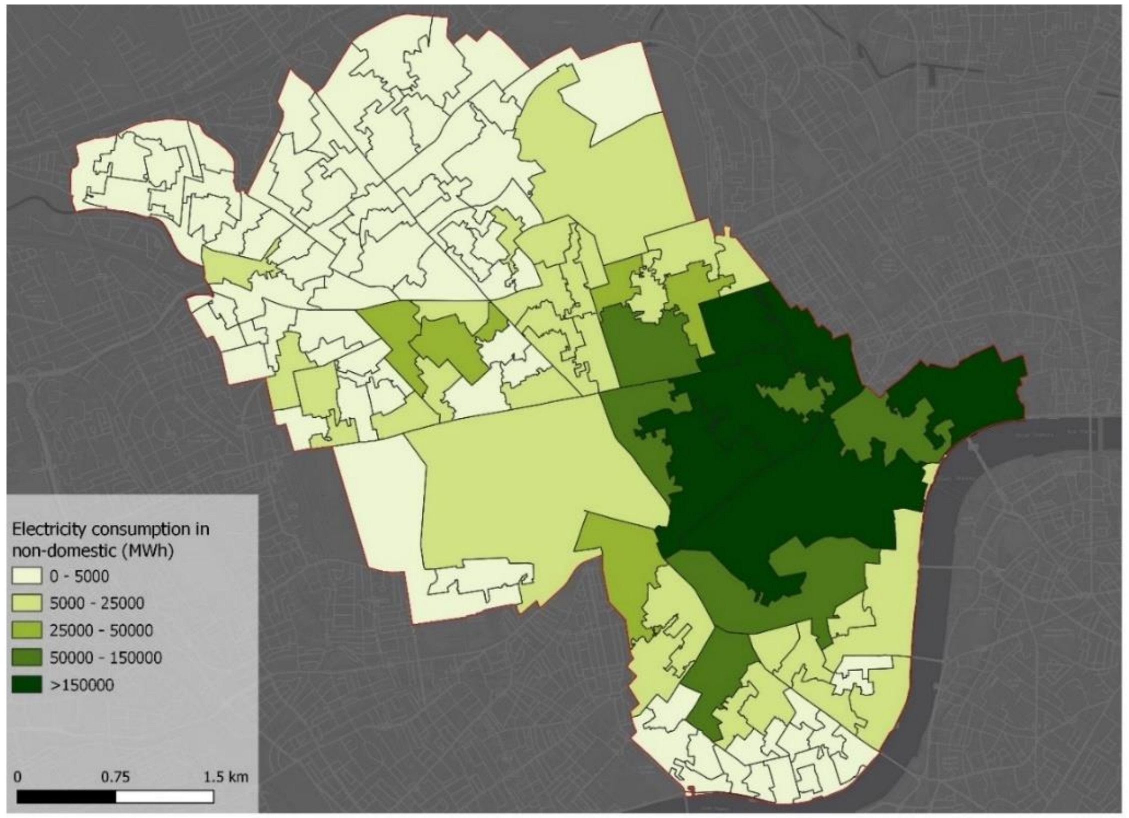


Figure 0—12 Electricity consumption in non-domestic properties by LSOA in Westminster

Westminster City Council assets

Approximately 24,354 of properties in Westminster are owned by Westminster City Council, among those 23,595 are domestic and the remaining are non-domestic. Figure 0—13 provides the WCC asset ownership map. It is important to note this is a land not building ownership based map. It is inferred that any building on this land is in WCC ownership, however, the influence and direct control over such buildings is likely to vary. It is thus an indication only.

Figure 0—13 Westminster City Council asset ownership map

In terms of energy performance, the WCC-owned domestic properties outperform other domestic properties in Westminster with about 48% with EPC ratings C and higher, compared to about 37% for all domestic properties in Westminster. Figure 0—14 shows the distribution of EPC ratings in Westminster assets.

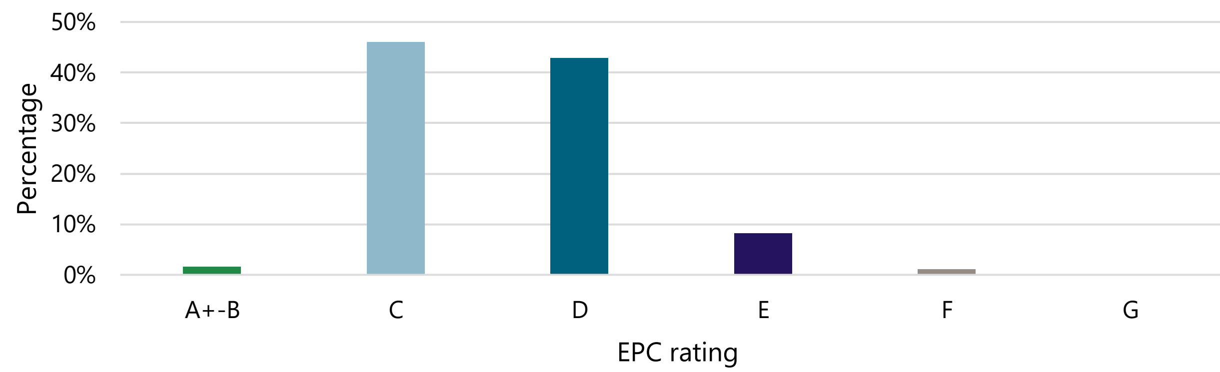


Figure 0—14 Share of EPC ratings in domestic properties owned by WCC

The total annual gas and electricity consumptions in WCC-owned assets is estimated to be about 276 GWh and 106 GWh, respectively. Figure 0—15 illustrates the extent to which the gas and electricity consumptions in Westminster are utilised in WCC owned assets.

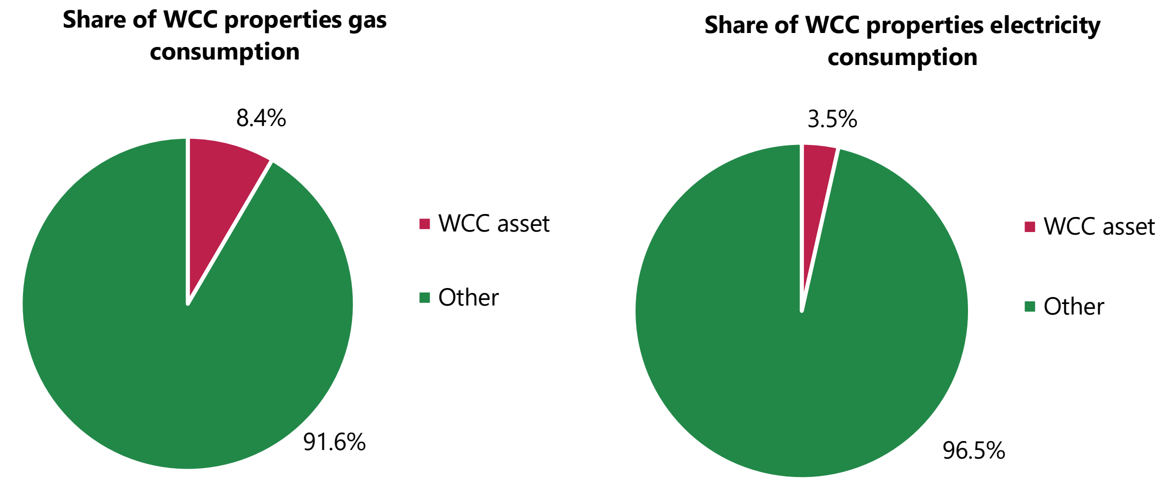


Figure 0—15 Share of gas and electricity consumptions in WCC assets in Westminster

Despite a smaller number of WCC-owned non-domestic properties compared to WCC-owned properties, WCC- owned non-domestic assets have higher heat demand as shown in Figure 0—16 along with related carbon emissions. This is primarily because WCC ownership of several high-demand properties including schools, leisure centres, museums and art galleries.

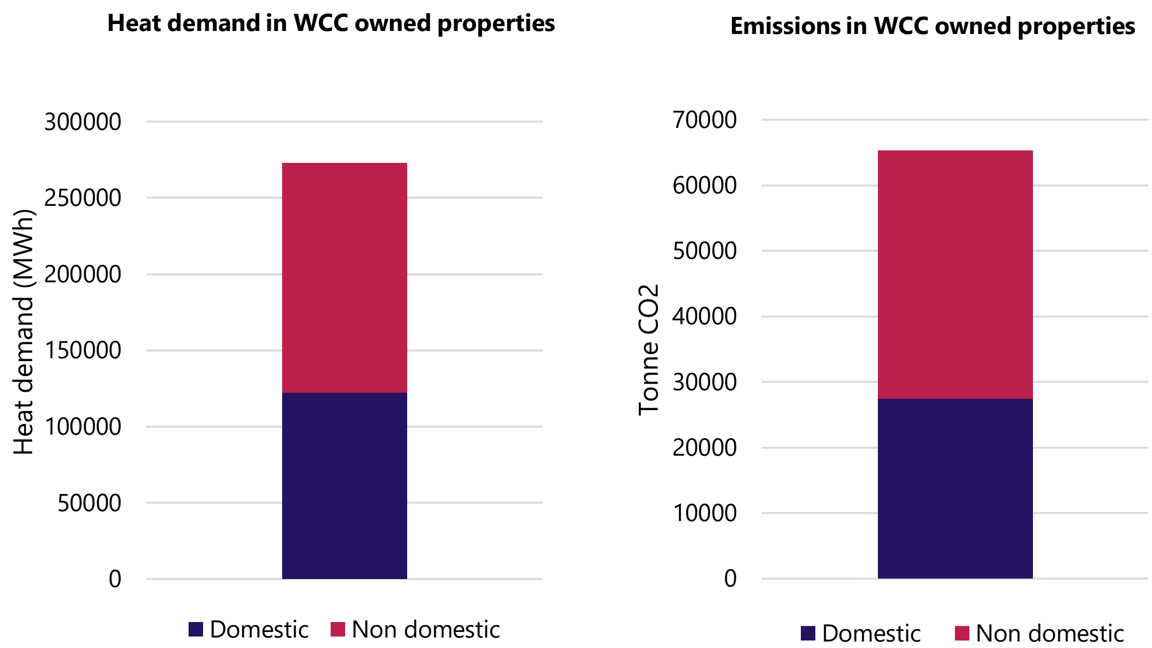


Figure 0—16 Heat demand (left) and Carbon emissions (right) in WCC-owned domestic and non-domestic properties

Heat pump systems

This section explores the potential for individual heat pump solutions in properties in Westminster. The focus is on identifying properties suitable for replacing their existing heat system with heat pump.

Domestic heat pumps

Strategic scale review of domestic heating systems

Figure 0—17 displays the LSOA level map of all domestic properties suitable for heat pump upgrades (top map). The map in particular highlights areas in northwest, west and southwest with a large number of suitable properties for heat pump deployment. Considering the building tenure, the bottom map highlights the areas in the northwest with a high number of WCC owned properties which are suitable for heat pump deployment. In order to identify areas suitable for heat pump deployment, a number of factors are considered as follow:

- Property type: Only houses (terrace, detached, semi-detached and bungalow) are assessed for heat pump installation since there is less space constraints for heat pump installation in these property types compared to flats.
- Building ownership: Local authority owned properties and social housing properties historically have a higher likelihood for adopting low carbon policies and are more likely to switch/ replace their heating system. The ownership offers a potential for a large-scale roll-out of heat pump in these properties. In private-owned properties, the Government scheme such as "Boiler Upgrade Scheme" can accelerate the adoption of heat pumps.
- Building Energy efficiency level: Heat pumps perform more efficiently in well-insulated properties. Therefore, improving the building energy efficiency is also important alongside heat pump installation. This also enables smaller heating system and reduce the need for grid reinforcement. Among 13,220 properties around 20% of them have EPC B and C, making them suitable for heat pump upgrade with minimal intervention. 58% of properties have EPC D where some easy retrofits like loft top up, cavity wall insulation and draught proofing are required. Most of the remaining properties, require more extensive retrofit measures including wall insulation and glazing upgrade. As Figure 0—18 shows some of the potential areas for heat pump installation contain a high number of properties with poor energy performance. This underscores the need for fabric upgrades to achieve optimal heat pump performance in those areas.
- Building current heating system: Properties with a gas boiler are proven to be more suitable for individual heat pump deployment, as they already have a radiator and piping system necessary for the heat pump.
- Conservation areas and listed buildings: Among the properties suitable for heat pumps, 11,000 properties are in conservation areas where specific regulations apply, for instance, on land within a Conservation Area or World Heritage Site, air source heat pumps must not be installed on a wall or roof which fronts a highway. Furthermore, 1024 of these properties are listed and require planning permission for heat pump installation. This does not preclude the installation of heat pump technology but does add additional constraints to locate suitable space to house the plant.
- Heat network zoning legislation: Moreover, the focus has been on the properties with the annual heat demand below 100MWh. This is mostly because demands above 100MWh may be mandated for heat network connection from 2025 when heat zoning legislation kicks in or be more suitable for communal heating. Further discussion on heat network and communal heating system can be found in section 0.

The total number of properties identified as suitable for replacing their current heating system with a heat pump is about 13,160 in Westminster with around 1,027 of these properties being owned by WCC.

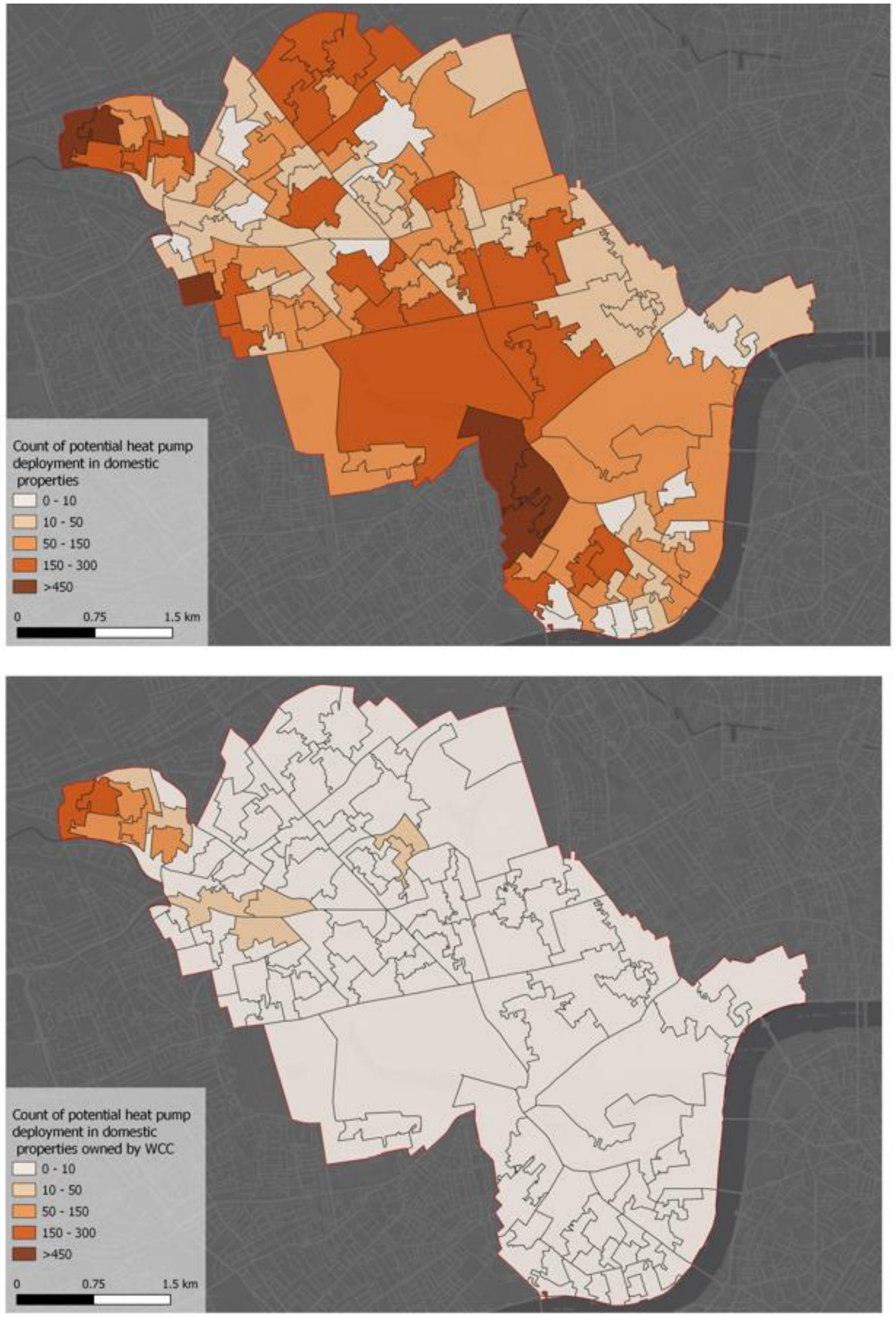


Figure 0—17 LSOA level count of potential heat pump installations in domestic properties in Westminster (top) and in WCC owned properties (bottom)

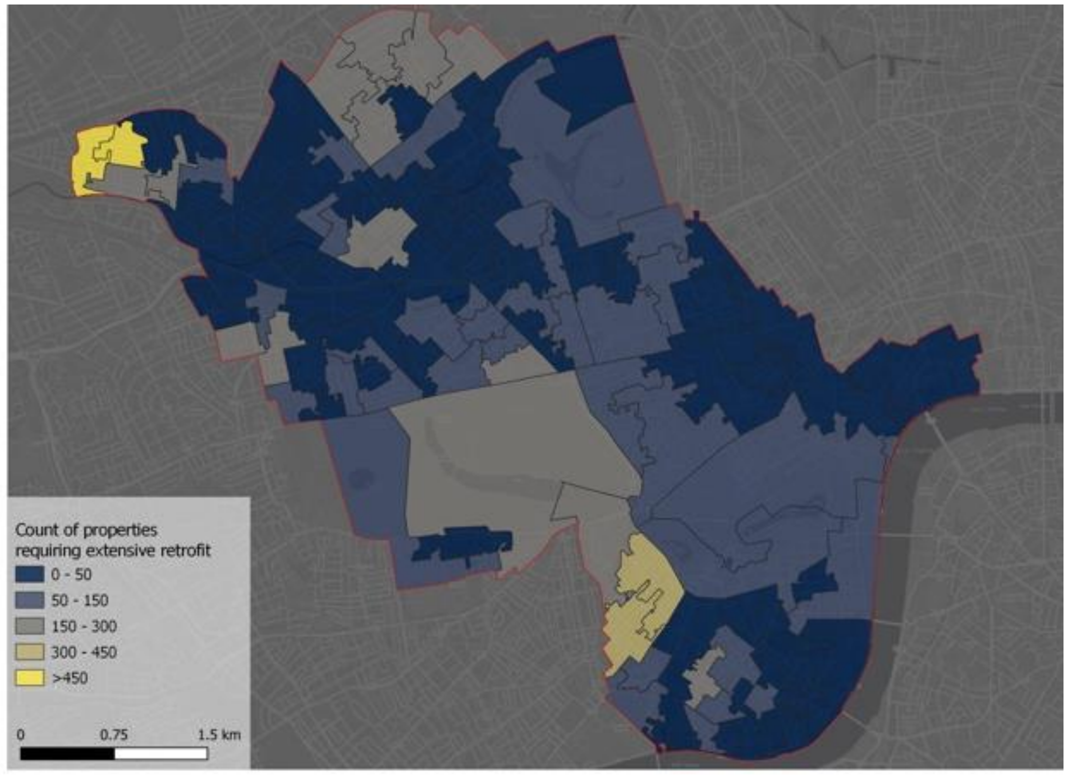


Figure 0—18 The count of properties requiring extensive retrofit measure at LSOA level

Available headroom / grid capacity in existing primary substations in the borough could accelerate the heat pump roll-out. The areas with high available headroom suited better for immediate heat pump deployment. Figure 0—19 provide a map of electricity grid capacity in Westminster.

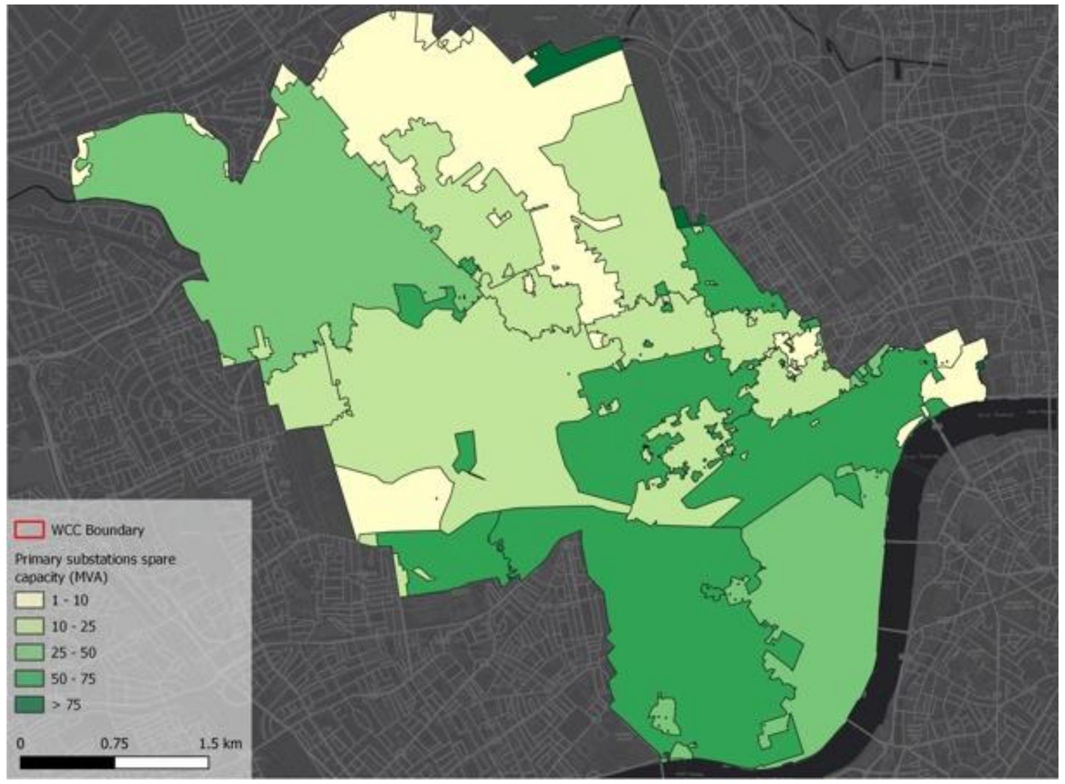
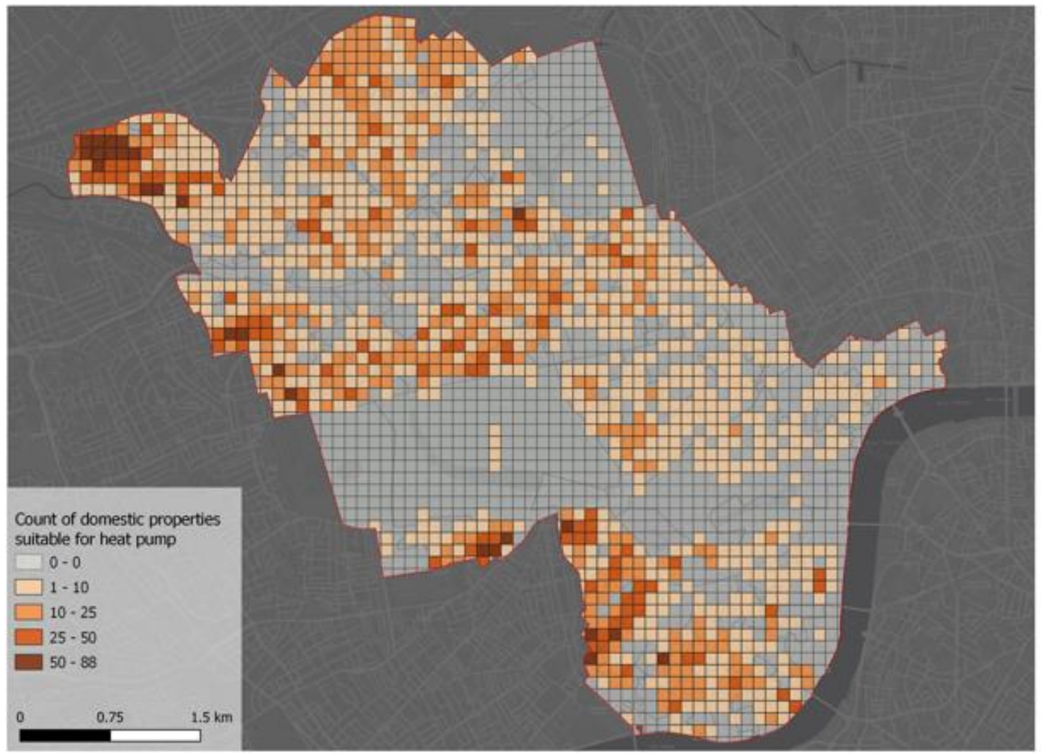


Figure 0—19 The spare capacity in primary substations supply area in Westminster

Delivery scale review of domestic heating systems

Figure 0—20 depicts the count of domestic properties suitable for heat pump installation at 100 m grid level in all properties and in WCC-owned properties. The figure provides higher resolution of the areas suitable for heat pumps and informs the priority areas for roll-out.



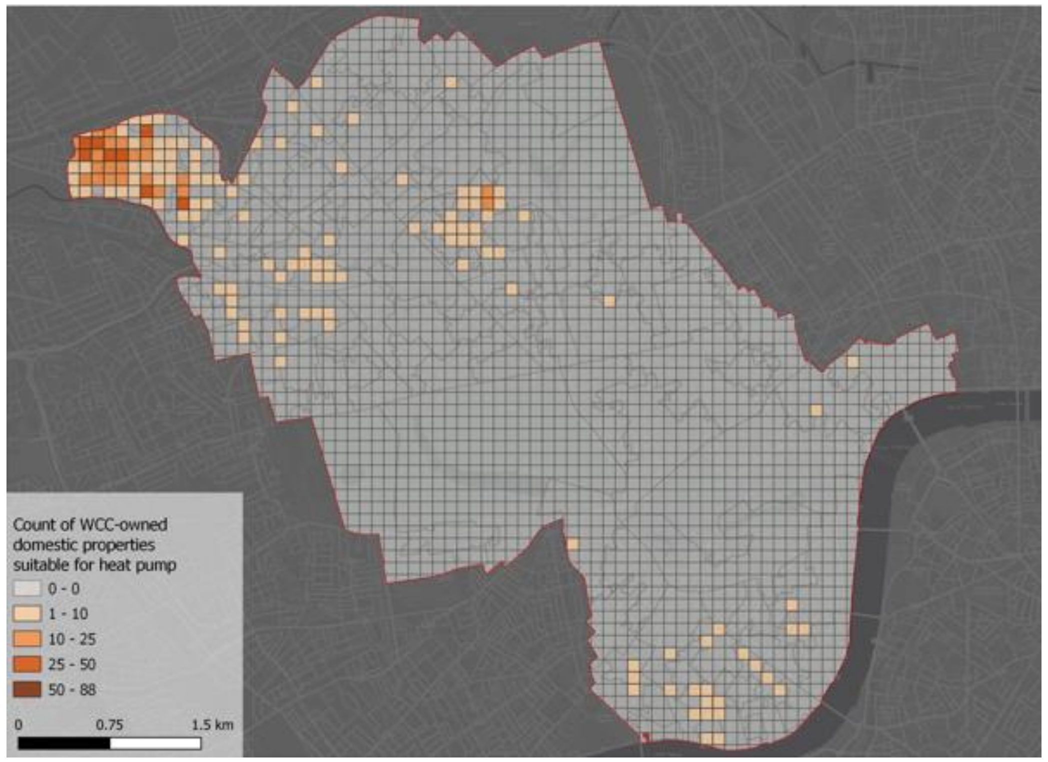


Figure 0—20 100m grid level count of potential heat pump installations in domestic properties in Westminster (top) and in WCC owned properties (bottom)

Multiple factors, including the overall number and percentage of properties suitable for heat pump, the count of WCC owned properties, possible influence by WCC, commonality in typology and the grid available headroom, are considered to prioritise areas to focus on for heat pump project, as highlighted in Figure 0—21.

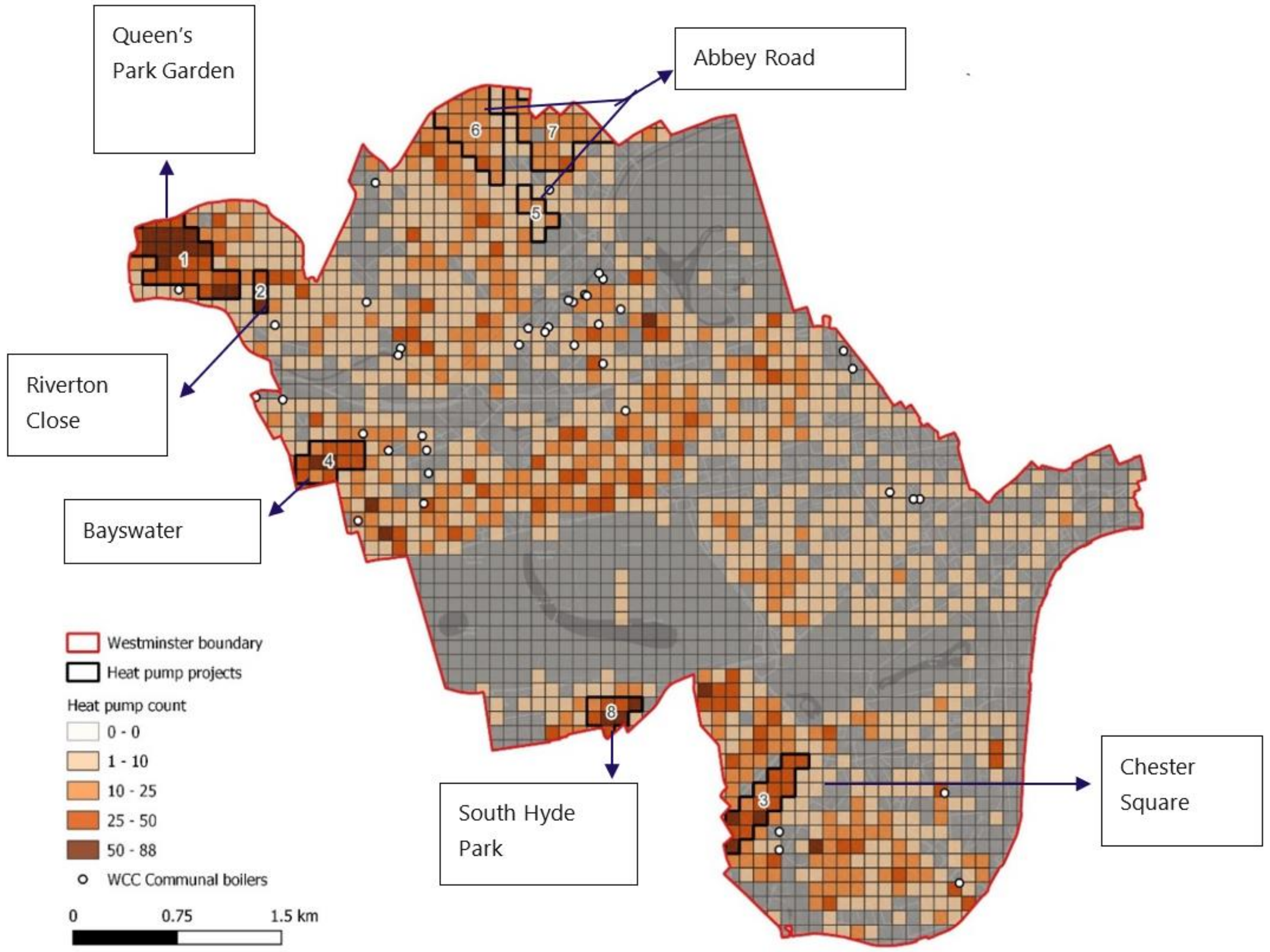


Figure 0—21 Overview of prioritised area for potential heat pump roll-out

Opportunity areas for heat pumps include:

Queen's Park Garden area, where most of the properties are terrace houses, with about 950 WCC- owned properties. However, the properties are rather poor from energy performance and combining the heat pump rollout along with fabric upgrade is required. The area is also located in North Paddington Program.

Riverton Close with about 120 WCC-owned low-rise flats and terraced houses. Some building already benefited from communal heating; this could be an opportunity for a small-scale communal heat pump project as well.

The **Abbey Road** area with a large number of detached/ semi-detached properties that reduce the space barrier for HP installation. However, the limited grid headroom could pose a challenge for large scale roll-out.

In the **south Hyde Park** area, there is potential for heating system decarbonisation through heat pump in about 300 private-owned terrace houses currently using gas heating.

The **Bayswater area** mainly consisting of private housing low-rise flats and about 500 terraced houses.

Chester Square area, primarily consisting of private housing with about 600 properties suitable for heat pump installation. Due to high number of low energy efficiency properties in this area, some level of fabric upgrade is needed prior to implementation.

When considering a full heat pump roll-out in all properties suitable for heat pump, the estimated total cost of heat pump roll-out in Westminster ranges between £105m-£111m, depending on the extend of the fabric upgrade in properties (it should be noted the OPEX will also be higher in the low retrofit scenario. It would cost about £7m to install heat pump in all domestic properties owned by WCC deemed suitable for individual property level heat pumps.

Table 0—2 Summary of electricity demand and cost for property level heat pump roll-out in Westminster for different fabric upgrade scenarios.

Scenario	Count of properties	Number of properties retrofitted	Electricity demand for heating (GWh)	Cost of heat pump install (m£)
High Ambition	13163	12489	58.7	105
Low Ambition	13163	3190	67.5	111

It should be noted that improved fabric reduces the technical requirements of heat pumps, including capacity in some instances. This leads to a reduction in the total cost in the high ambition scenario. However, this reduction in heat pump cost does not offset the increased investment required for fabric improvement.

Priority areas for combined domestic retrofit and heat pump deployment

A summary of the priority areas for domestic interventions and HP deployment early areas to consider in the analysis is provided in Figure 0—22.

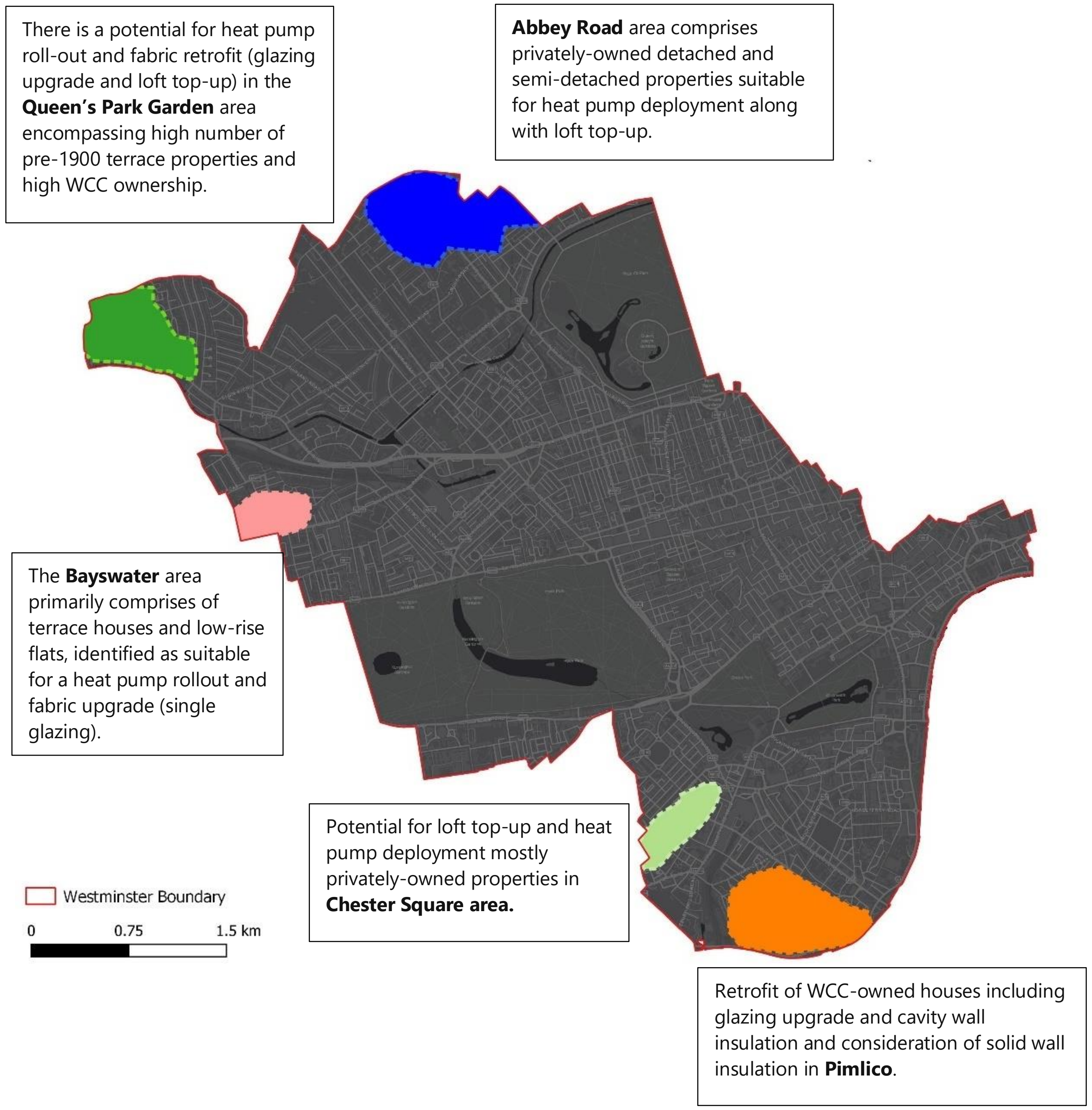


Figure 0—22 Overview of prioritised area for fabric upgrade projects

Non-domestic heat pumps

Strategic scale review of non-domestic heating systems

Non-domestic heat pumps at a property level are identified as the technology choice in 3400 non-domestic properties in the LAEP scenario. The distribution of these across Westminster is provided in Figure 0—23.

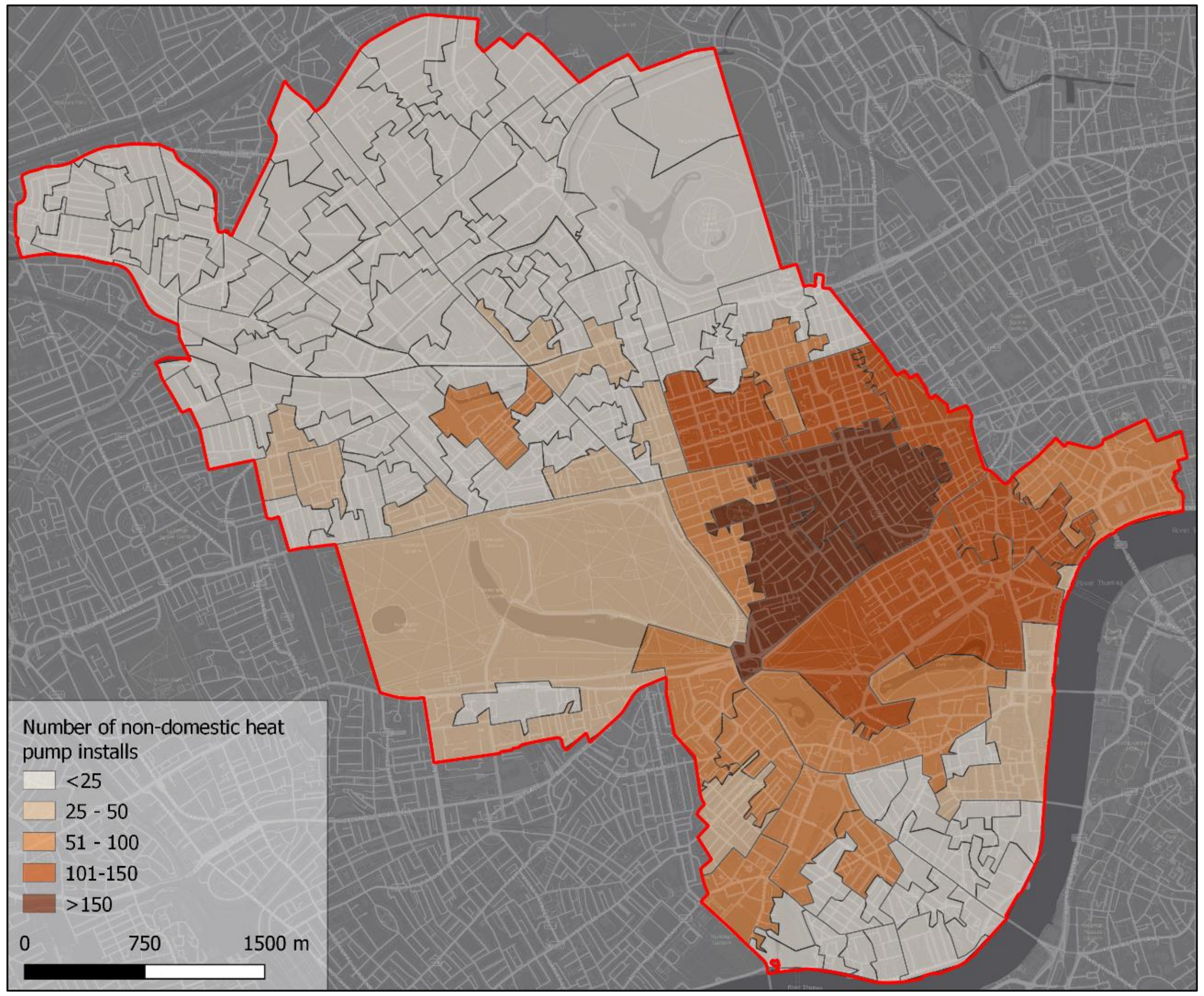


Figure 0—23 Overview of non-domestic heat pump installs at LSOA level. Basemap from ESRI and contains Ordnance Survey Crown Copyright material.

The focus of property level heat pump deployment the West End and St James areas. This is despite the large number of non-domestic demands connecting to communal heat pump solutions and wider heat networks in this area. Whilst these larger scale solutions may take more time to deploy the large number of heat pump opportunities identified show that heating system decarbonisation opportunities with a shorter lead in time.

Delivery scale review of non-domestic heating systems

Non-domestic heat pumps are explored at a finer resolution, more suited to targeted delivery, in Figure 0—24.

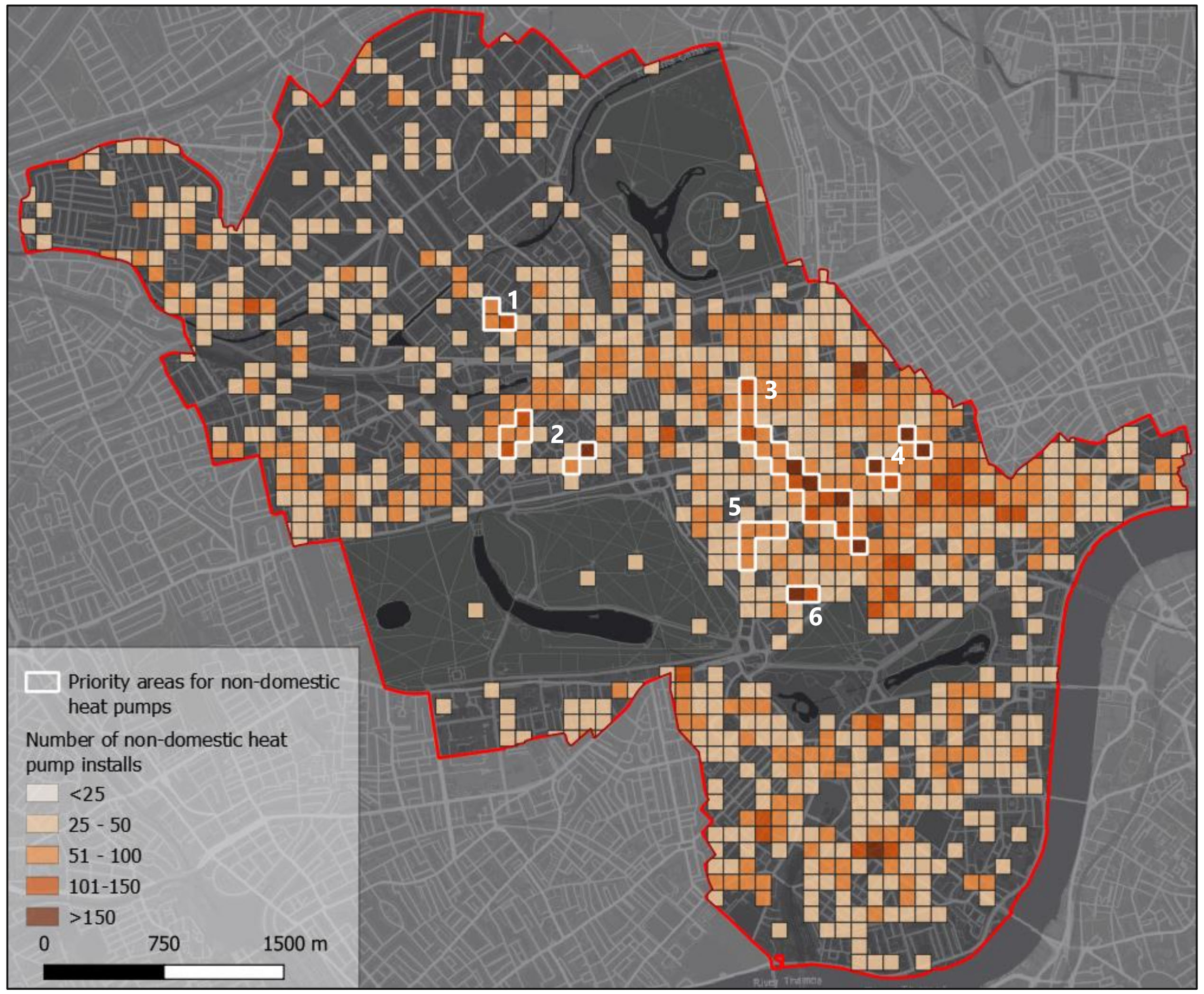


Figure 0—24 Delivery scale view of non-domestic heat pump installations. Basemap from ESRI and contains Ordnance Survey Crown Copyright material.

The priority areas also consider other decarbonisation options for selection – to help make them low regrets a summary of these priority areas is provided below:

- **Area 1** at the **west edge of Church Street heat network** zone is a priority as it is important to establish in the heat network study which is currently ongoing whether these buildings will be viable for connection. If not carrying out heat pump installation is a low regrets opportunity. The area also has a high number of properties on WCC land assets making them an early focus for decarbonisation.
- **Area 2** near **Gloucester Square** includes a large number of relatively small hotels, which generally suit heat pump technology due to often requiring both heating and cooling provision. The area is also identified for communal systems and is likely to use a combination of heat pumps at different scales to serve both individual and multiple properties. The economics between these two options was shown to be relatively marginal, and not being identified as a priority for heat network connection, means it is considered relatively low regrets to deploy either communal or individual heat pumps.

- **Area 3** is focused around **Thayer Street, South Molton Street and Albmarle Street**. Both Grosvenor and Howard de Walden great estates have influence over the area. Whilst in general the West End is shown as a major heat network opportunity, the somewhat smaller building level demands in this area are relatively well suited to building level heat pump solutions. This makes it a lower regrets area for early decarbonisation of heating in the West End without relying on the long lead time of heat network deployment.
- **Area 4** on **Carnaby** and **Berwick Streets** is a priority due to the high density of relatively small non-domestic buildings heated by gas boilers. There size of the heat demands associated with these buildings means they are unlikely to be the focus of a heat network, falling below the 100 MWh/yr demand threshold being promoted by DESNZ.
- **Area 5** along **South Audley** and **Mount Streets** was selected as although the overall counts are low, they equate to a large percentage of properties being flagged as being suitable for heat pumps. Some of the area is also flagged as suitable for domestic heat pumps – but the higher threshold required to be a focus area for domestic heat pumps was not met. However, examining the area in further detail for both domestic and non-domestic heat pumps will be of value – ensuring the electricity network and any reinforcements this will be at the lowest cost.
- **Area 6** on **Shepherd Street** (to the south of Curzon Street) is identified has a high density of non-domestic properties identified for heat pumps. These properties have a high share of pubs, cafes and restaurants. Being relatively small buildings, they were not identified as priority for heat network connection and having a common use and building typology means a common approach for heat pumps can be considered.

Non-domestic individual property level deployment and cost summary

The majority of non-domestic heat pumps identified are relatively small in size, with larger demands generally being connected to heat networks in the scenario. As such the scale and costs of the systems are not greatly different to large domestic systems, with the overall cost being ~£18000 per property. For the 3400 individual non domestic systems installed this results in a total cost ~£61 million.

Communal heating systems and heat networks

This section explores the deployment of heating systems at a communal and heat network scale.

Existing heat networks

Communal heat networks (see Table 0—1 for definition) are widely spread across Westminster. There are 43 WCC boilers operating communal heating systems and small-scale heat networks. The locations of these systems alongside all communally heated buildings is illustrated in Figure 0—25.

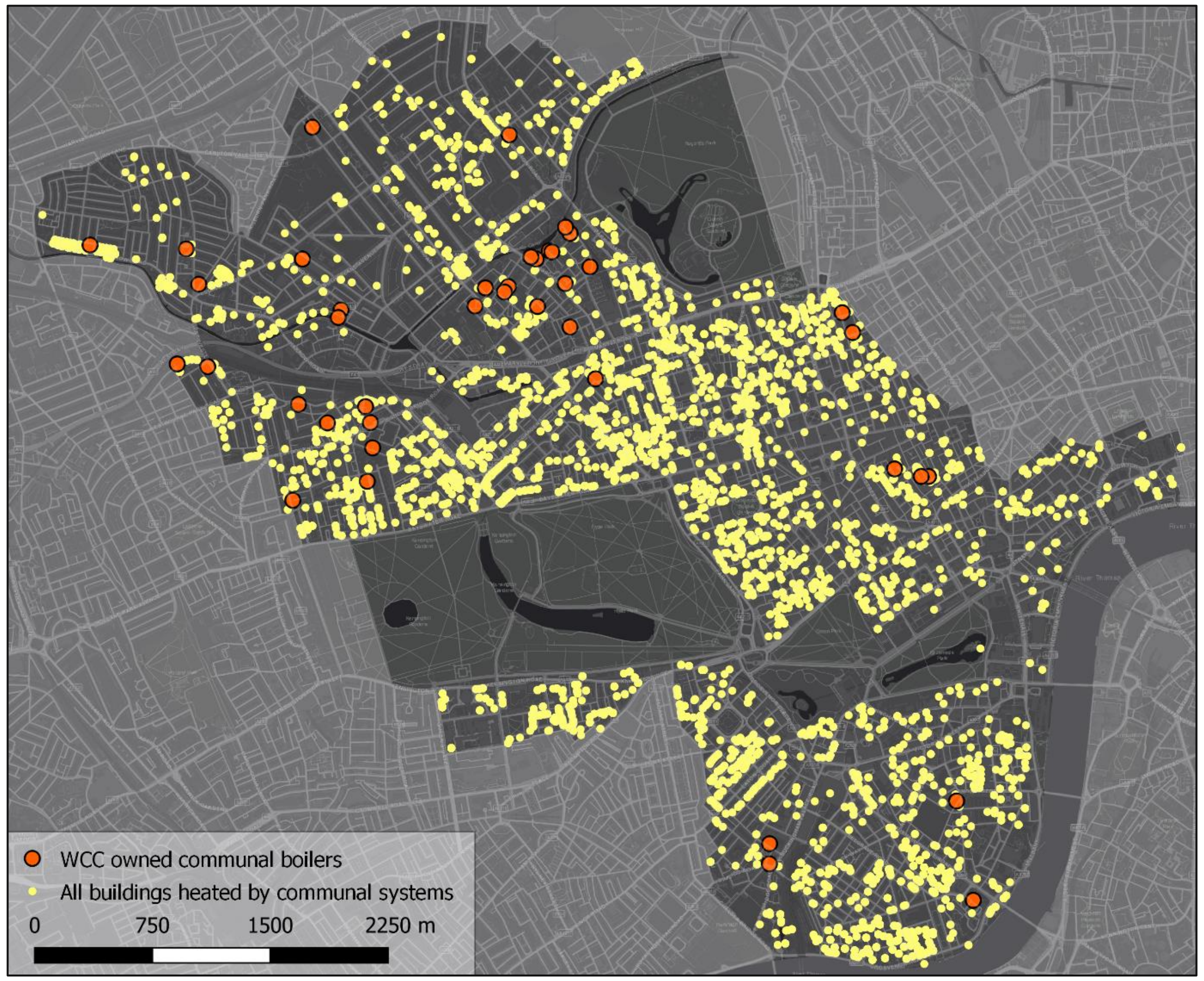


Figure 0—25 Location of communal heating systems in Westminster.

Westminster contains the Pimlico District Heating Undertaking (PDHU) is the oldest district heating scheme in the UK and the largest in London, being developed and built in the 1940s and 1950s and currently supplying heat to over 3,200 households across three estates, 50 commercial customers and four schools. Heat is produced from two gas-fired combined heat and power engines (CHP) and three large boilers co-located in the main energy centre in Churchill Gardens. Studies are currently underway to look at its decarbonisation.

The other major network in Westminster is the Whitehall network. There is a proposed connection between the two systems, known as the 'South Westminster Area Network' or SWAN. This is marked in the London Heat Map, an extract from which is provided in Figure 0—26.

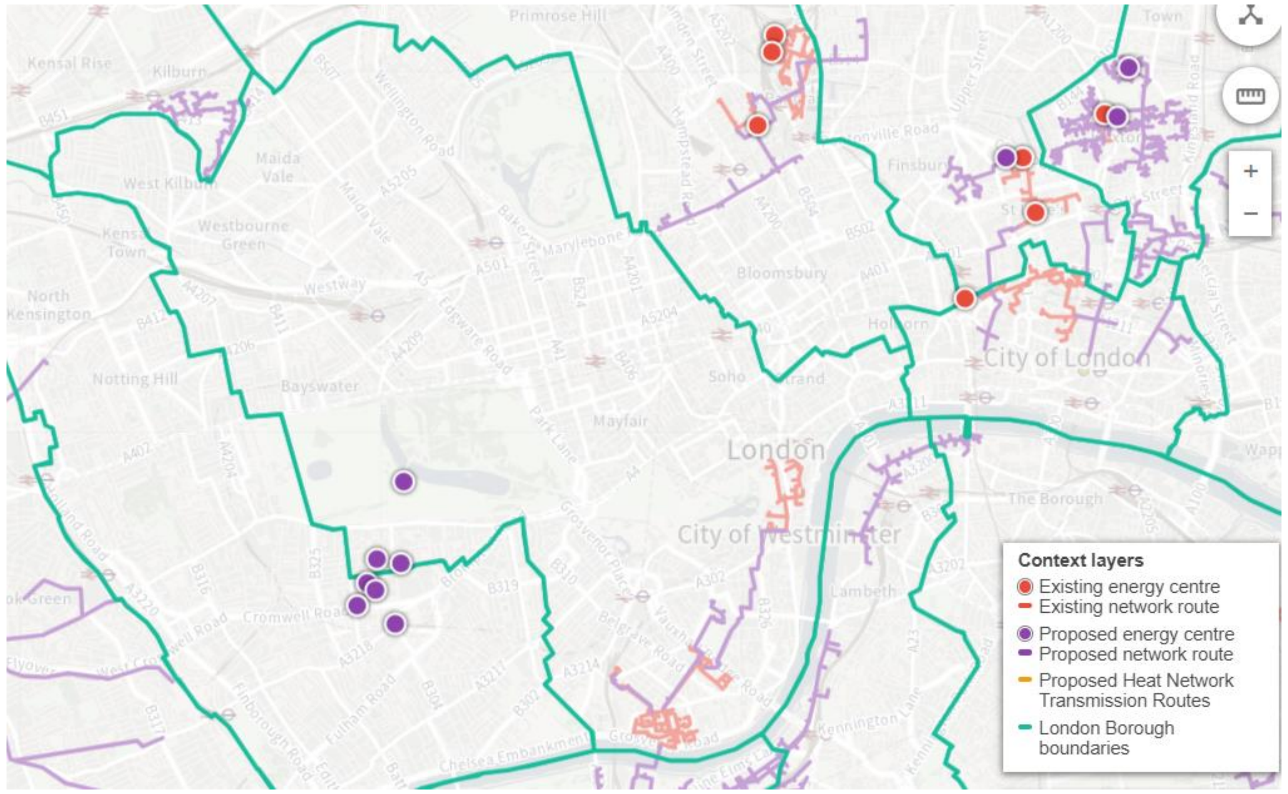


Figure 0—26 Heat network projects in Westminster identified in the GLA London Heat Map

The other area which shows a high level of activity in terms of proposed networks is the area around Imperial and the Royal Albert Hall, where the South Kensington museums and Imperial College are currently investigating a combined scheme.

Heat sources and technology options

The scale of communal systems and heat networks (see Table 0—1) for a summary of the difference between these systems) means a broader range of heating technologies can be considered for them to deliver low carbon heat.

More conventional low carbon systems include:

Air source heat pumps are considered for property level systems (as discussed in sections 0) but also communal and in some instances heat networks. Air source heat pumps are the most widespread technology as they are not constrained by geography like the other heat pumps considered.

Ground source heat pumps are not considered in many instances for property level solutions, given the complexity of utilities in the ground and lack of land generally associated with individual properties in Westminster. However, they are considered for both communal and larger heat networks. The relatively extensive public greenspace across Westminster means that for such an urban environment there are areas that could be considered for such schemes, although their historic significance and high use would create challenges.

Water source heat pumps are less widely deployed than air or ground source but are being explored in Westminster already (see 0). These systems work best with flowing water, making the Thames the largest potential heat source (with the National Heat Map estimating available heat in excess of 300MW) and Regent's Canal the second largest potential source.

Waste heat sources can also be captured, often in conjunction with a heat pump to lift temperatures, which can significantly increase efficiencies in heat production into a network. An appraisal of waste heat was taken to identify potential sources of heat for heat networks and communal systems in Westminster. The main waste heat sources fall into the following groups:

Waste heat from **retail chillers** (particularly in food stores) – have some potential but they are not large enough to make a substantial impact on larger heat network areas identified in Westminster. There could be some potential for smaller communal systems.

Waste heat from **air conditioning** – sites with a high level of air conditioning were identified, this was predominately based on analysis of non-domestic building stock. Rather than focusing on direct harvesting of waste heat, as heat demand will generally be lowest when air conditioning demand is at its highest, the focus of this waste heat source is on identifying areas for replacement with combined heating and cooling systems where localised heat recovery can be implemented.

Waste heat recovery from **data centres** – is increasingly becoming recognised as a potential source for heat networks, due to a relatively continuous use of cooling equipment. In total 10 data centres were identified in Westminster; however, the scale of potential heat source is hard to quantify as they are integrated into existing buildings. Further investigation of these sources is recommended.

Transformers at large **electricity substations** – produce a high volume of heat and in some instance, this can be effectively harvested. Of the 25 large substation data points considered the National Grid substation at St Johns Wood was identified as having potential of a scale suitable for larger heat networks (~14.9 GWh/yr).

Heat from the **underground network** – was considered for heat supply. This is used in the Bunhill heat network in the neighbouring Borough of Islington, however, there is a high level of data sensitivity relating to vent shafts (which are the best source of capture) underground stations are used as a proxy in any map outputs. However, we able to establish 14 vent shafts of note fall in Westminster – two of which were identified in a TfL study as showing reasonable potential.

Waste heat from **sewerage** – was the final waste heat source identified. Thames Water identified one site of particular interest – a pumping station in the southwest corner of Westminster.

Various other waste heat sources were explored but they were either not present in Westminster or in other cases did not fulfil zero carbon assessment criteria. The location of potential waste sources identified are presented in Figure 0—27.

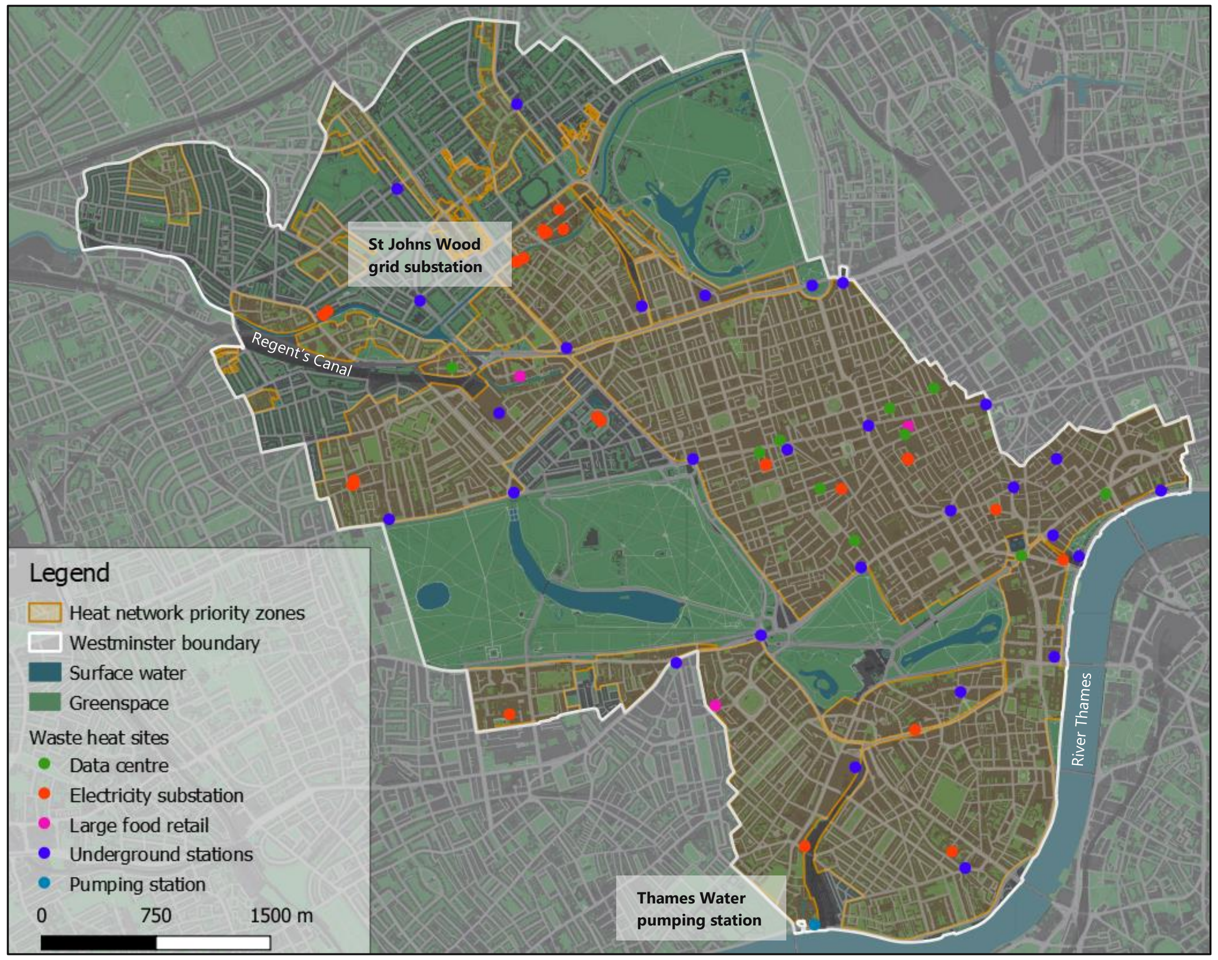


Figure 0—27 Waste heat sources identified. Uses OS Crown Copyright, ESRI, European Waste Heat Map and various data sources collated by Buro Happold.

Although 68 potential heat sources are identified in Figure 0—27, only two (St Johns Wood substation and the Thames Water pumping station) are considered of large enough scale for heat supply at a level which could make substantial contribution to wider heat networks. Along with two potential vent shafts that were identified in a TfL this equates to only four waste heat sources – the waste heat from which is at least an order of magnitude below the demand in the heat network areas of the LAEP. This means the majority of heat will need to be supplied by other low carbon sources, nominally heat pumps or potentially waste heat from neighbouring areas.

Alongside heat pumps other technologies will be considered, such as electric boilers for peak heat demand, but the majority of the heat demand from communal and district heat networks will be met by heat pumps.

Existing communal systems and heat networks

As discussed in 0 there are only two large scale existing district heat networks in Westminster, PDHU and the Whitehall networks. There are also many communal networks as well. These systems are primarily fossil fuel based. The connection of the PDHU and the Whitehall network and their associated decarbonisation with the SWAN project is a relatively well-established pathway to net zero.

The communal boiler systems are more widely spread across Westminster.

Potential heat network zones

Initial analysis of heat networks highlighted that all built up areas of Westminster could be considered for heat networks. This is also reflected in earlier outputs from heat network zoning analysis carried out by the Department of Energy Security and Net Zero. However, for the Final LAEP Scenario there is a mix of different technologies. The large extent of potential heat network zones in Westminster means a level of prioritisation is required. Various factors, including heat density, type of heat demands, WCC ownership, heat supply opportunities and new developments were considered in this prioritisation exercise. Key initial areas to examine are marked on Figure 0—28.

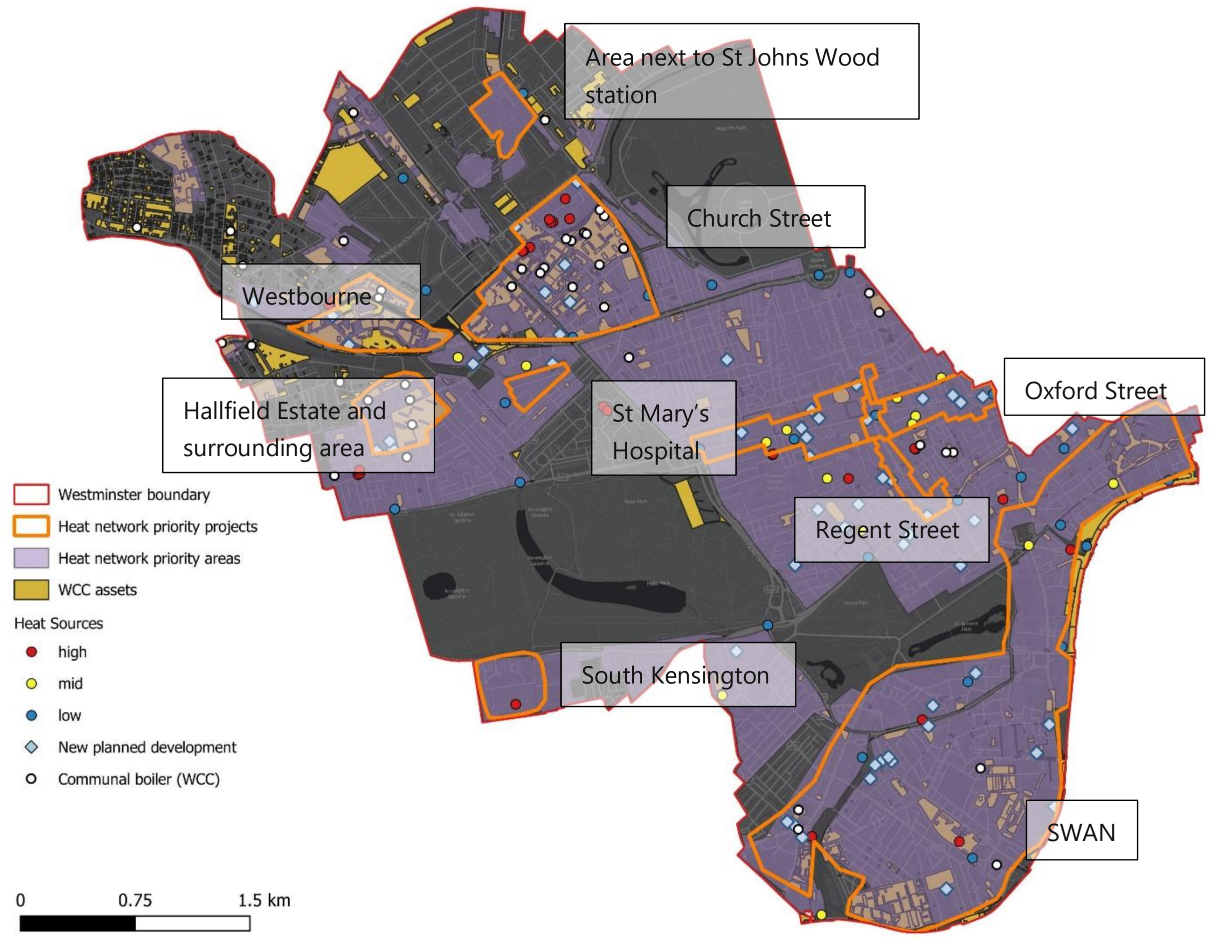


Figure 0—28 Overview of priority heat network areas

It should be noted that heat networks can be viable outside of the identified areas in Figure 0—28, due to the high heat density of Westminster, but they are identified as somewhat more marginal. A summary of the heat network priority areas that were identified as early areas to consider in the analysis is provided below.

- The **South Westminster Area Network** (also known as **SWAN**) is a major heat network that is current being pursued linking the existing Pimlico and Whitehall district heat networks and connecting other large demands in the area. The majority of heat is planned to be supplied from a large water source heat pump in the Thames. This aligns to the modelling outputs of the LAEP and is thus considered as the main decarbonisation route in the area highlighted in Figure 0—28. It should be noted that property level and small communal systems will also be deployed in this area but that the majority of heat will come from SWAN.

- The area around the **South Kensington** is currently being considered for a heat network, progressing through various feasibility stages. This would potentially connect the Royal Albert Hall, Imperial College London and other large institutions in the area such as the Royal College of Music with other key demands outside of Westminster – these include the Natural History Museum and the Victoria and Albert Museum. The analysis indicates that this could be extended along the southern edge of Hyde Park. Continued engagement and collaboration with the Royal Borough of Kensington and Chelsea (which could contain the majority of a potential network) as well as other key stakeholders, notably South Ken ZEN+, will help track progression and identifying any relevant assistance for aiding delivery.

- An opportunity was identified in **Oxford Street** Due to high heating and cooling demand and proximity to Hyde Park, which provides opportunity to explore ambient loop systems. Given the outputs of the Department of Energy Security and Net Zero's heat network zoning programmes and the fact that most of the Westminster falls in a heat network zone, this could be a viable option for heat network development in the area. It would also help develop an evidence base for heat networks in these more challenging areas. One barrier to development of this network opportunity is timing, as the Oxford Street programme, which aims to improve the overall useability and apparency of Oxford Street, is already at an advanced stage, meaning aligning works to the programme may prove challenging

- It was also noted in stakeholder workshops that the Crown Estate bisects the proposed zone with their extensive ownership in the **Regent Street** area. Combining the two developments could create a spine for heat networks in this challenging area of Westminster for deployment. The Crown Estate are developing their own strategy and feasibility studies for heat network opportunities in their land, these have been integrated into this LAEP strategy. This area was also highlighted by the City of London of being in close proximity to substantial waste heat sources (notably data centres).

- **Church Street** has a high level of WCC ownership, this includes existing communal systems that could act as valuable anchor loads. The area is in close proximity to the large grid substation at St Johns Wood (a potential source of waste heat) and has a number of planned new developments in the area with large anticipated demands. A previous feasibility study has confirmed its viability WCC have commissioned a new study to analyse available heat sources and consider a heat pump solution.

- **St Mary's Hospital** is undergoing major redevelopment. It is, and will continue to be, one of the largest single heat demands in Westminster. This makes the redevelopment a key opportunity to develop a network in the immediate area. This opportunity was flagged by AECOM in the Heat Network Zoning work being carried out for DESNZ. It should be noted that in the Advanced Zoning Programme this is referred to as Paddington.

- The area next to **St Johns Wood Station** has several large heat demands suitable for heat network connection, including St John and St Elizabeth Hospital, schools, nurseries and clinics. Due to a lack of WCC ownership and being in the area with grid constraints, this is not considered as an initial project. However, within the LAEP all properties need to decarbonise and in this area a heat network solution appears to be the most viable option. Therefore, it is highlighted as high heat network opportunity, but other projects identified take priority in the LAEP.

- The **Westbourne** area has a large number of flats (which include some existing communally heated properties), Westminster Academy, a clinic and high proportion of Westminster owned assets. It is also next to Regent's Canal, which could be considered for a water source heat pump and Westbourne Green Open Space that could potentially host boreholes for ground source heat pumps. These factors combine to make the area one of the priority heat network areas identified in Westminster.

- The final priority heat network project identified includes the **Hallfield Estate** and the surrounding area. This has a high level of WCC ownership, including existing communal heating systems. The area also includes a large primary school and the Queensway development, which comprises new homes, retails and offices. The Hallfield Estate includes greenspace which could host boreholes for ground source heat pumps and potential some air source heat pump capacity. It should be noted that this is a relatively time critical project as the new developments are progressing and WCC has a communal boiler replacement programme. Aligning the strategy will be key to minimise costs associated with a heat network in the area.

Multiple heat network opportunities exist outside of these priority projects and areas, but they provide an initial focus. The heat network areas were also cross checked against the Advanced Zoning Programme (AZP) for heat networks (which is being carried out in Westminster by Aecom on behalf of DESNZ). The LAEP and initial outputs of the AZP work align well – with all of the AZP areas identified also being captured in the LAEP.

Communal system opportunities

The transition to communal systems is initially assessed at the building level. Buildings with multiple gas heated properties are the priority for communal solutions. Such buildings make up ~25% of Westminster (~7700 buildings), these are considered in two main groups those over 100 MWh/yr that could be mandated for heat network connection based on DESNZ Heat Network Zoning and those under 100 MWh/yr (i.e. not prioritised for heat network connection based on DESNZ analysis). These smaller buildings make up the majority of communal systems, with ~5400 in total. The distribution of both the larger and smaller heat demand communal systems is provided in Figure 0—10.

The larger communal systems are focused around Soho, whilst smaller communal systems are more widely spread in residential areas. It should be noted that although multiple small communal systems are identified in the Pimlico area with the existing PDHU network and the wider SWAN scheme these are prioritised for wider heat network connection rather than single building communal systems.

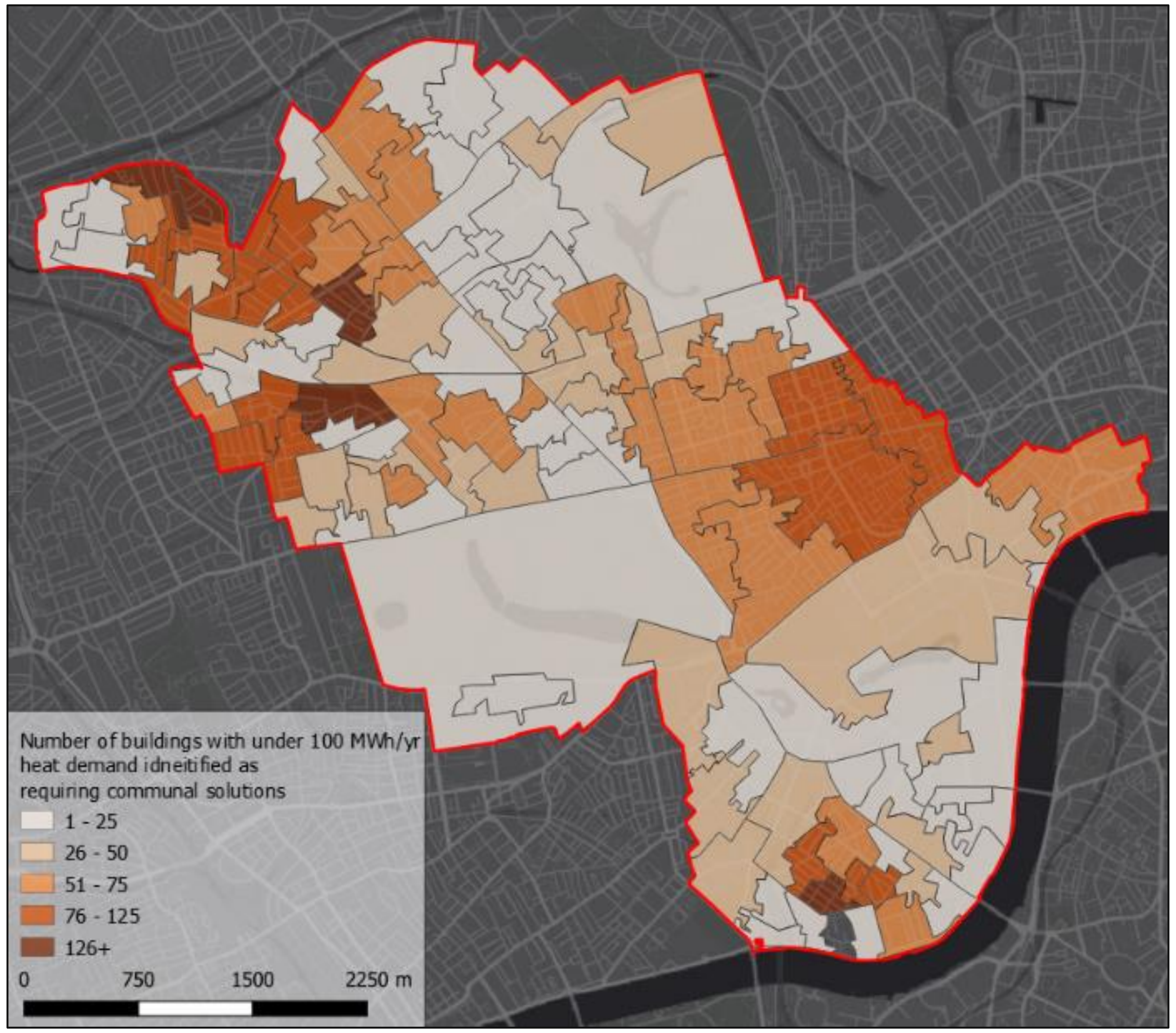


Figure 0—29 Distribution of building level communal systems Multiple property buildings that are less likely to connect to a heat network. Uses OS Crown Copyright, ESRI, European Waste Heat Map and various data sources collated by Buro Happold.

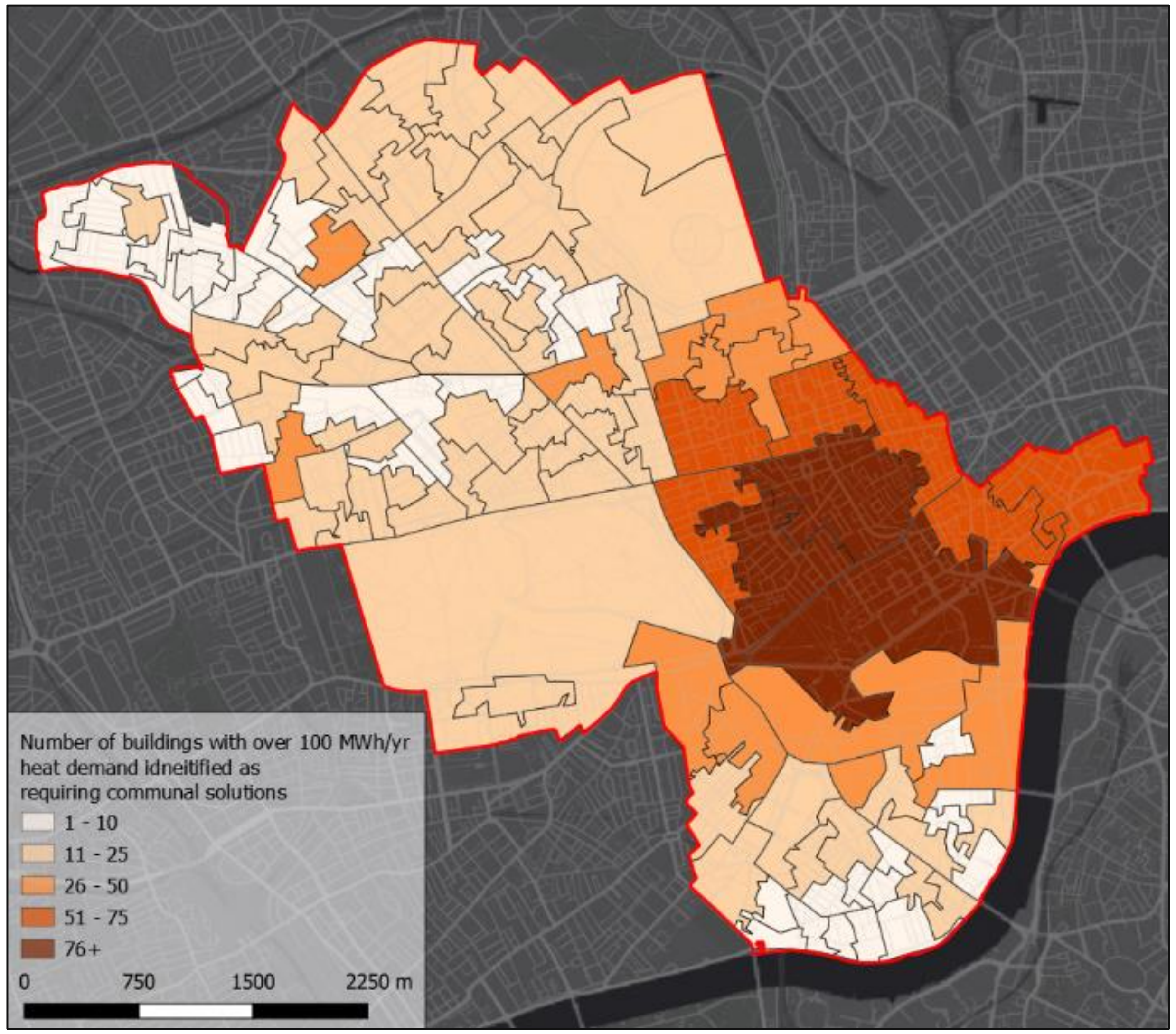


Figure 0—30 Distribution of building level communal systems - Multiple property buildings that are more likely to connect to a heat network. Uses OS Crown Copyright, ESRI, European Waste Heat Map and various data sources collated by Buro Happold.

A more detailed breakdown of focus areas for communal heating systems is provided in Figure 0—31. These focus areas consider the scale of communal heating systems identified (i.e. buildings with a heat demand <100 MWh/yr are less likely to connect to a heat network[23]), proportion of WCC asset ownership, heat network priority zones.

[23] This aligns to proposed thresholds for heat network connections suggested by DESNZ.

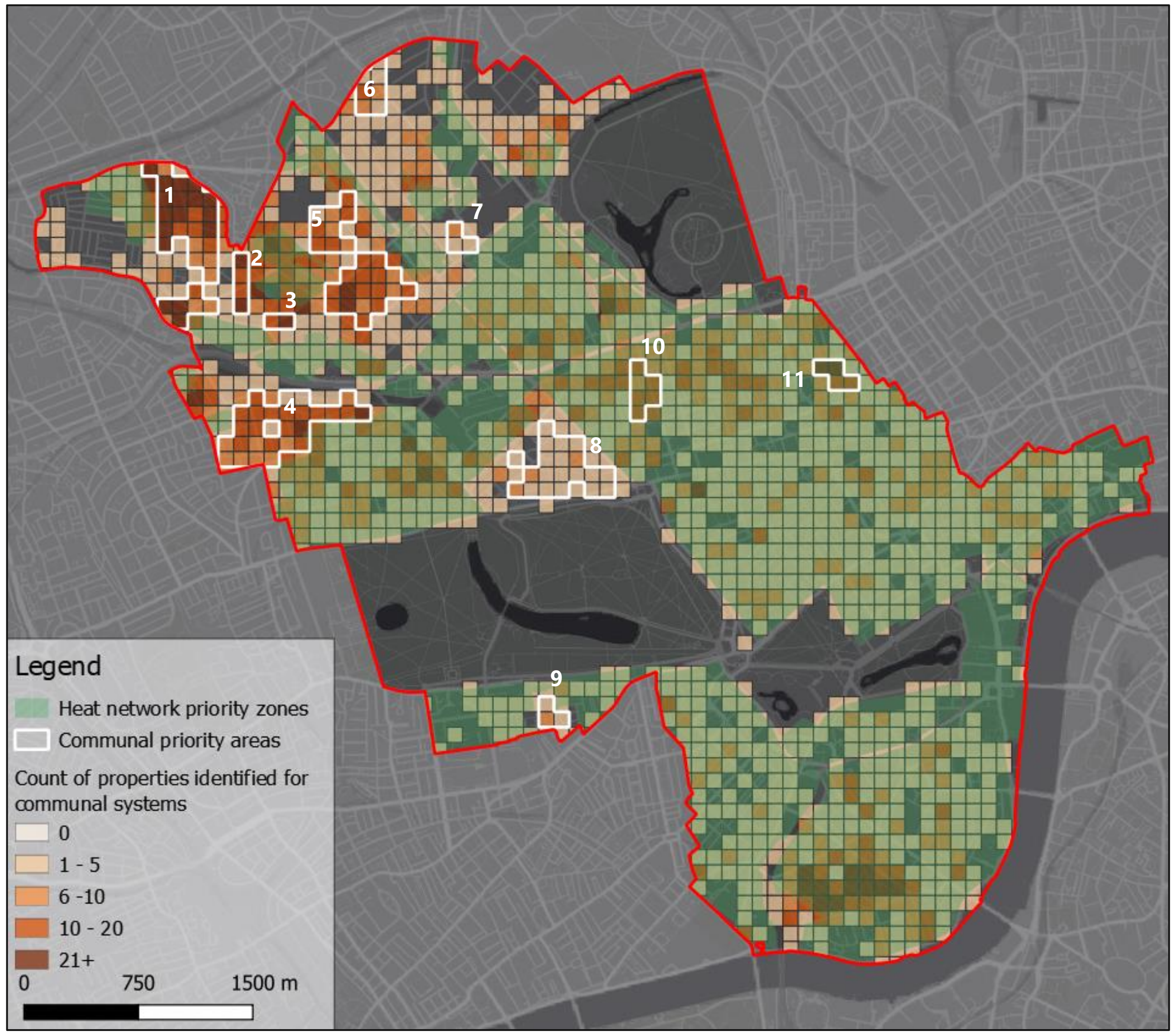


Figure 0—31 Identification of areas for priority consideration of communal heating projects.

Area 1 which **Fernhead Road** runs down the centre of has a very high portion of small communal systems identified. This means there a high volume of similar projects, delivery of which can be scaled. The properties are extensively small scale flats mixed with terrace properties, so whilst the model highlights communal systems it will also be suitable for relatively large scale deployment of property level heating systems. Location outside of a conservation area means deployment of visible heat pumps will be less challenging from a planning perspective. This is important as given the scale of the flats a ground mound system may be more appropriate than a rooftop system.

Area 2 on the **east side of Chippenham Road** is similar to Area 1, being characterised by relatively small blocks of flats and again not being in a conservation area. The limited space means deployment of heat pumps at a property level is likely to be untenable. This means they are not identified as good opportunities for heat network connection. This area has a lower presence of WCC assets than Area 1. Consequently, this will increase the challenge of early deployment of communal systems as it will require engagement with the private sector.

Area 3 at the **west end of Sutherland Avenue** is a small priority area selected due to the very high proportion of buildings that are identified as being suited for communal systems. The area is in a conservation area and would be a good test for widescale deployment of communal systems addressing this constraint. The buildings are dominated by commercial space on the ground floor with flats above. This typology means a communal system can be cost effective, benefiting from the different heating profiles. Historic England have published a report which has several of examples of communal heat pumps in similar contexts in Westminster[24].

Area 4 to the **south of Royal Oak station** is an area with relatively few large demands surrounded by areas more suitable to heat networks. It is dominated by terraced domestic properties that are identified as buildings with multiple properties. It includes a high proportion of WCC ownership, with a particular focus around **Porchester Square**. It includes 24 existing communal boilers, which present an initial focus for decarbonisation. This has also been highlighted as a potential heat network area – a more detailed feasibility study as an early action would be useful to identify whether combining the communal systems or decarbonising them separately would be most effective.

Area 5 around the **Formosa and Crescent Gardens** is again dominated by large terraces of historic multiple property buildings. Being relatively small building level heat demands the area is not highlighted as a focus for heat networks. The relatively extensive greenspace near many of the buildings does increase the possibility for shared ground loop communal systems.

Area 6 to the **west of Abbey Road** was highlighted due to a high proportion of the properties (even though total counts are relatively usual) being identified as switching to communal systems. The lack of heat networks identified in the immediate vicinity make it a low regrets option and six communal boilers already in the area present an easy option for initial decarbonisation.

Area 7 in **Scott Ellis Gardens** was identified as it has a high proportion of WCC ownership and three existing communal boilers to decarbonise. The majority of properties are WCC owned flats, meaning the greater influence can be used to help encourage an earlier switch. Additionally, the WCC owned land around the flats could help enable heat pump deployment.

Area 8 around **Gloucester, Connaught** and **Hyde Park Squares** does not have many large typical anchor loads for heat networks. However, it does have a large number of relatively small hotels as well as historic terraced domestic buildings with multiple properties as well as more modern flats. The former will likely be relatively easy (in terms of suitable building fabric) to switch to low carbon heating systems. There are already a large number of communal boilers in the area – allowing for relatively simple decarbonisation of multiple properties. It should be noted that in the High Heat Network scenario this was identified as a heat network area – with the large number of communal systems being aggregated to a larger network.

Area 9 between **Ennismore Gardens** and **Montpelier Square** was identified as an area for communal systems. Despite being surrounded by areas identified for heat networks the buildings are generally domestic and do not reach a high enough heat threshold for connection to a heat network. Pursuing communal systems in the area also allows some early decarbonisation in the Knightsbridge and Belgravia ward without relying on heat network deployment.

Area 10 on and around **Dorset Street** is in an area which is identified to include a heat networks. However, the building in this area were relatively small in terms of heat demand and so not considered a priority for connection. Also, the mix between domestic and non-domestic properties will improve diversity and help optimize system sizing.

[24] Historic England, 2023: Heat Pumps in Historic Buildings. https://historicengland.org.uk/images-books/publications/air-source-heat-pumps-historic-buildings/heag316-heat-pumps-historic-buildings/

Area 11 is similar to Area 10 in that it sits inside a large heat network zone but contains a large number of buildings that do not have a combined heat demand of the DESNZ threshold for connection. The area around **Great Titchfield Street** includes a mix of flats and non-domestic properties in the same building, suiting a shared system approach. Additionally, there are several WCC owned buildings and nine communal boilers presenting an early decarbonisation opportunity.

These communal projects identified could to some extent be considered for wider heat network connection, due to the high heat density of Westminster. However, areas 1-7 fall outside major heat network priority zones and are thus considered relatively low regrets options. With areas 8-11 although they fall in or near major heat network zones it is important to recognise not all buildings in a zone will connect to a heat network, and the typologies of these buildings means an individual property level solution is not viable. Furthermore, the switch to a communal scheme early in the decarbonisation pathway does not preclude future connection to a large district heat network in the future.

Cooling

Cooling is considered within the LAEP, with the need common across scenarios. Many of the low carbon heating systems installed, with the majority being heat pump based, can function effectively to provide cooling or heating. This improved comfort is a benefit of switching to low carbon technology. As well as the heating/cooling systems the improved fabric efficiency of the buildings will also help with thermal comfort. An increase in electricity demand is assumed to account for the greater need for cooling, this is incorporated into operational costs of the energy system and network upgrades.

Local Power generation

The electricity grid is decarbonising rapidly, see Figure 0—1. This is set to continue, with further deployment of large-scale renewables such as offshore wind developments being a key enabler nationally, as well as more localised deployments such as solar photovoltaics (PV). However, localised geographies cannot rely solely on national decarbonisation, with local generation of renewable electricity important to all LAEP strategies.

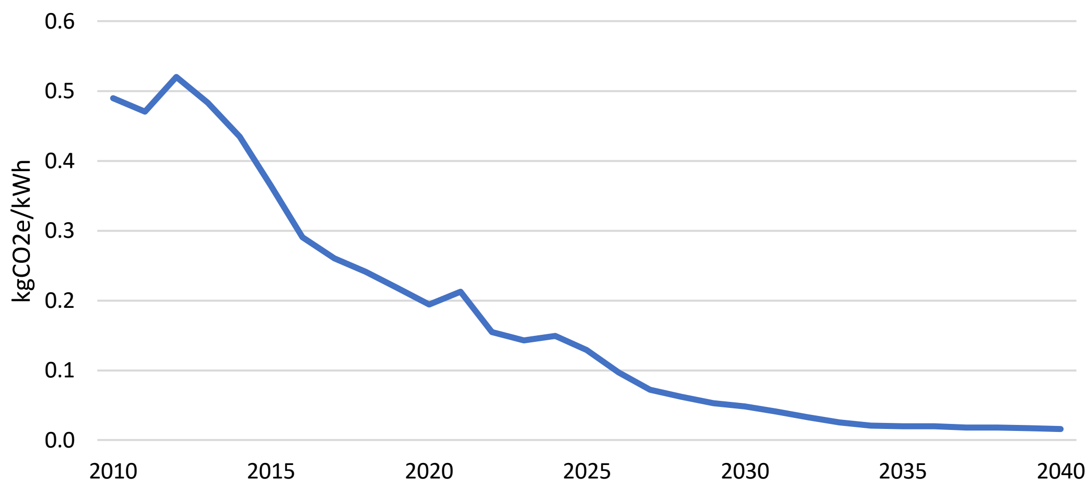


Figure 0—1 Electricity Grid emissions factor (based on Green Book standard emissions[25])

The deployment of local renewables within a LAEP is informed by different targets including London specific policies, as well as insights form other scenarios such as the FES and DFES. More ambitious timings for net zero will necessitate larger local renewable deployment.

This section provides an overview the potential renewable capacity in Westminster, which is used to inform the level of adoption in the LAEP scenario.

Renewable generation

Due to Westminster's dense urban environment and large concentration of conservation and protected areas, technology options which may be developed at scale are extremely limited. As such, rooftop PV is considered the only suitable technology to be deployed at scale in the borough.

Based on limited available data there is currently ~2 MW of installed Solar Photovoltaic (PV) in Westminster, with 57% of this capacity from installations less than 4 kW and 43% from installations between 4 and 150 kW, with no installations greater than 150 kW currently documented. It is likely this is somewhat of an underestimation but provides an indication of the current scale.

The Renewable Energy Planning Database[26] (REPD) does contain a 200 kW PV array 'awaiting construction' in Crompton Street with this array being owned and operated by Westminster City Council. The REPD also indicated a second PV development within the borough, currently 'under construction' within the Dolphin Square Estate, however the capacity of the array is unknown.

Opportunities to incorporate solar technologies (especially larger capacity installations) may be challenging in Westminster, due to the historic nature of much of the building stock. Westminster previously trialled Solar Together[27], which was a scheme that operated in Westminster providing solar panels and battery storage. The general principles of Solar Together schemes are:

1. Residents, small and medium-sized enterprises (non-domestic) and Commonhold Associations who own their property (or have permission from the landlord to install a solar PV system) may register for the Solar Together group-buying scheme.
2. An auction then occurs whereby pre-vetted solar installers will submit bids for the work and the installer with the lowest bid will win each auction and the property owner may then decide whether to accept the offer.

The scheme has currently ended and uptake in Westminster is understood to be low. There was a desire expressed in some of the stakeholder engagement for reintroduction of a similar scheme. Although any new scheme, should consider lessons learned from the previous experience of Solar Together. The GLA were involved in setting up Solar Together and therefore liaison with them is recommended to establish their plans for any future schemes and to feedback on potential improvements.

Rooftop PV generation potential

Although existing deployment of rooftop PV in Westminster is limited, the ambitions of the LAEP are high, particularly in early years. This is in part due to generally being quicker to deploy than other technologies and a higher grid carbon content in early years (Figure 0—2), maximising the impact on carbon reductions.

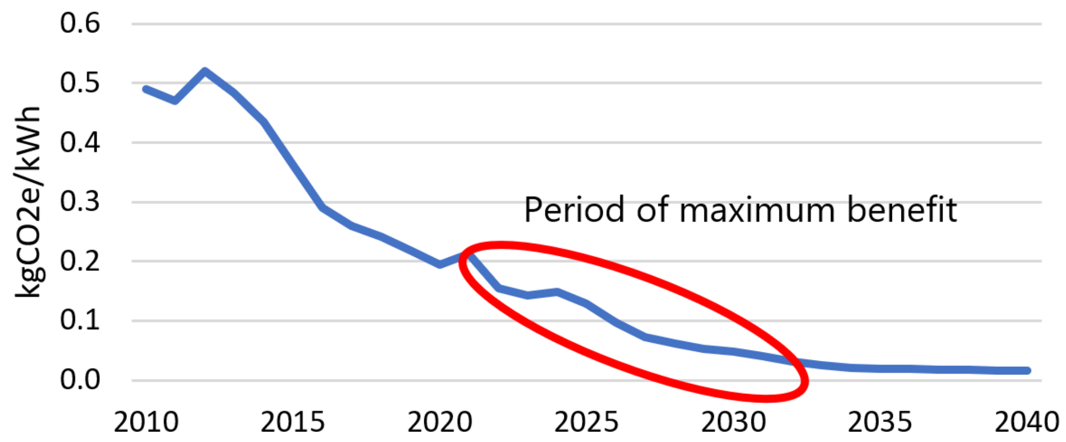


Figure 0—2 Future electricity grid emission factor[28]

Two exploratory deployment scenarios were developed initially to help determine the level of PV deployment in the LAEP:

- Stretch target of 118 MW (aligning to an even split of the 3.9 GW installed rooftop solar PV capacity targeted in the GLA's Accelerated Green Scenario for 2050, divided by 33 with the GLA responsible for the 32 London boroughs and the City of London Corporation). This target equates to a deployment covering 8% of the roof area in Westminster with PV panels. However, it should be noted that Accelerated Green does not assign this even PV split to boroughs.
- Minimum target of 61 MW this aligns to the Mayoral target of 2 GW across London, equating to ~61 MW in Westminster. This target equates to a required deployment covering 4% of roof area in Westminster.

These formed the context for the PV deployment target for the LAEP 90 MW. This is a mid-point between targets and a 50% increase in the Mayoral target. This level of deployment would equate to 6% of Westminster's roof area being covered with PV panels..

[25] https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal
[26] https://www.gov.uk/government/publications/renewable-energy-planning-database-monthly-extract
[27] https://www.westminster.gov.uk/tackling-climate-change-westminster/solartogether
[28] https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

Potential rooftop PV deployment

Analysis of the potential of rooftop PV generation per building was modelled for all non-listed buildings in the borough; listed properties were excluded due to increased complexity and barriers[29], and current planning constraints in some instances. Although it was noted in stakeholder workshops that listed properties can sometimes be perceived as more of an issue than in reality. In Kensington and Chelsea, for example, a policy has been introduced supporting PV deployment on Grade II properties.

After this exclusion the analysis can be summarised as:

1. Screening out roofs of under 10 m^2.
2. Removal of roof segments with a solar irradiance below 800 kWh/yr/m^2.
3. Removal of roofs with an angle over 50°.
4. Assumption of percentage of useable roof area that is available for PV (this is typically ~50%). This assumption is relatively conservative to account for other rooftop uses and to avoid overestimating potential.
5. Apply a PV power density to the available roof space based on solar panels currently on the market. This provides a theoretical installed capacity.
6. Once the theoretical installed capacity is calculated roofs with an installed capacity of under 1.3 kW are removed.

Steps 1-3 and 6 are to provide an initial screening of the most economic rooftops for this analysis.

This potential for roof mounted PV in Westminster equates to an installed capacity of 245.8 MW from a deployment area of 111.7 Ha, 16% of roof area in Westminster. With an annual generation of 236.9 GWh/yr, this annual figure equates to ~8% of the 2021 total electricity demand of Westminster[30]. Characterisation of the types of buildings and areas which make up this is potential is provided in Table 0—1.

Table 0—1 Potential rooftop PV statistics

PV Generation	Installed Capacity	Within Conservation Areas	Domestic	Non-Domestic	Council Owned
Annual generation (GWh/yr)	**236.9**	142.5	150.9	104.0	45.7
Installed Capacity (MW)	**245.8**	147.9	156.6	108.0	47.4

MSOAs have different levels of rooftop PV capacity based on roof type, size and building numbers as well as heritage building numbers and coverage of conservation areas (with conservation areas having been supplied a lower deployment coverage per building – the relative potential for rooftop PV per MSOA is illustrated in Figure 0—3.

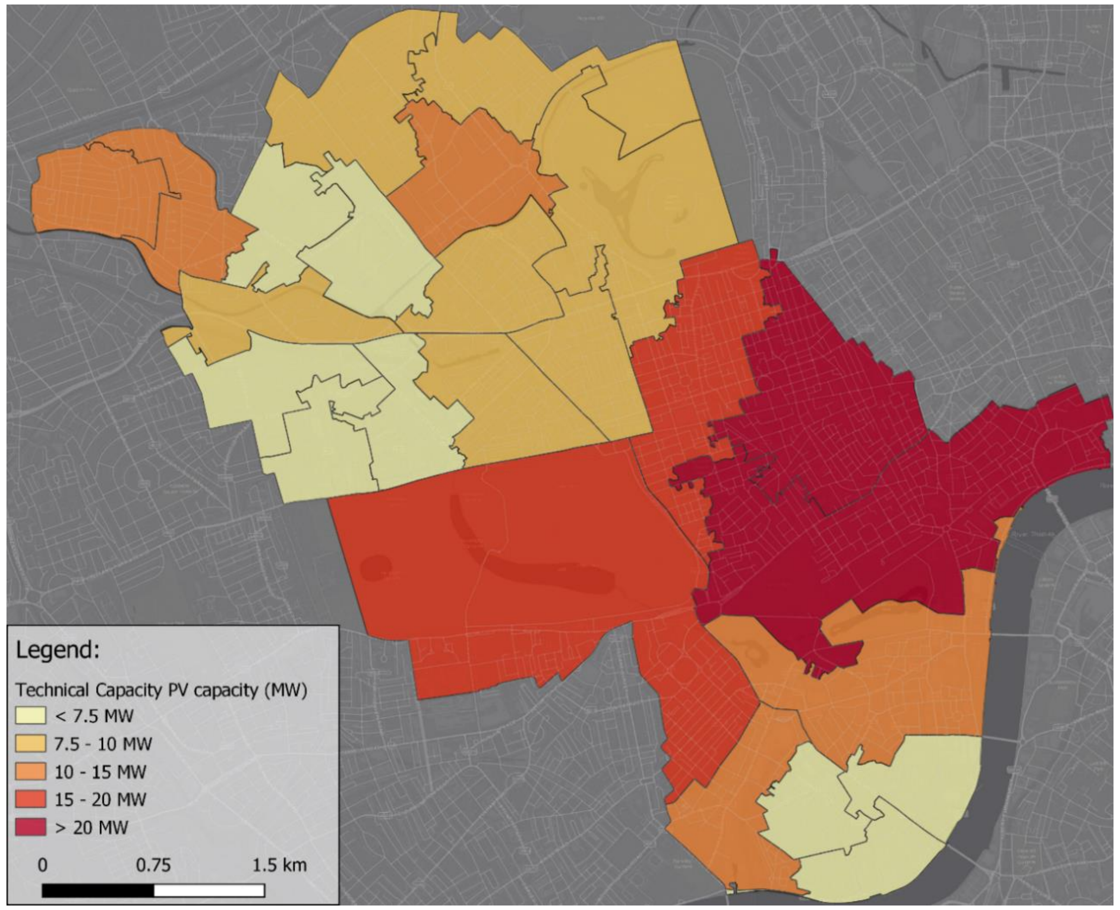


Figure 0—3 Potential rooftop PV capacity per MSOA

The five buildings with the largest PV potential capacities included within the study are below, with their associated total roof area and technical capacity.

Table 0—2 Five highest PV potential capacities

Capacity Rank	Building	Total Roof Area (m2)	PV Potential (kW)
1	BDO Baker Street	9,528 m^2	656 kW
2	Cardinal Place Shopping Centre	6,259 m^2	616 kW
3	National Rail Depot – Peabody Avenue	10,639 m^2	591 kW
4	BNP Paribas Bank	5,824 m^2	462 kW
5	Paddington Academy	4,695 m^2	452 kW

Although listed buildings are screened out it is useful to briefly note their potential as they represent some of the largest opportunities in Westminster. The five listed buildings with the highest potential in Westminster in regard to roof area are listed in Table 0—3, these are calculated based on the same analysis listed above.

[29] https://www.westminster.gov.uk/planning-and-climate-emergency/energy-efficiency-guidance-householders/solar-panels

[30] https://www.gov.uk/government/statistics/regional-and-local-authority-electricity-consumption-statistics

Table 0—3 Listed building PV analysis

Roof Area Rank	Building	Total Roof Area (m2)	PV Potential (kW)
1	Paddington Train Station	24,517 m^2	1,241 kW
2	Victoria Train Station	19,139 m^2	968 kW
3	Selfridges	16,152 m^2	817 kW
4	Ministry of Defence	12,627 m^2	639 kW
5	Department for Business and Trade	12,304 m^2	623 kW

All of the ~4,000 listed buildings in Westminster, have a combined roof area coverage of 125 Ha (18% of all roof area within Westminster) These buildings could thus potentially host an additional 63.25 MW of PV.

LAEP scenario rooftop PV deployment

The potential for roof mounted PV deployment in Westminster is estimated at 245.6 MW, however, full realisation and deployment of this potential is unrealistic. With the supply chain and electricity infrastructure being two limiting factors. The LAEP has a target deployment of 90 MW, or 37% of the theoretical PV potential for the borough. The PV panels would cover 6% of roof area in Westminster, with an annual generation of 86.7 GWh/yr. A split of this capacity by is provided in Figure 0—4.

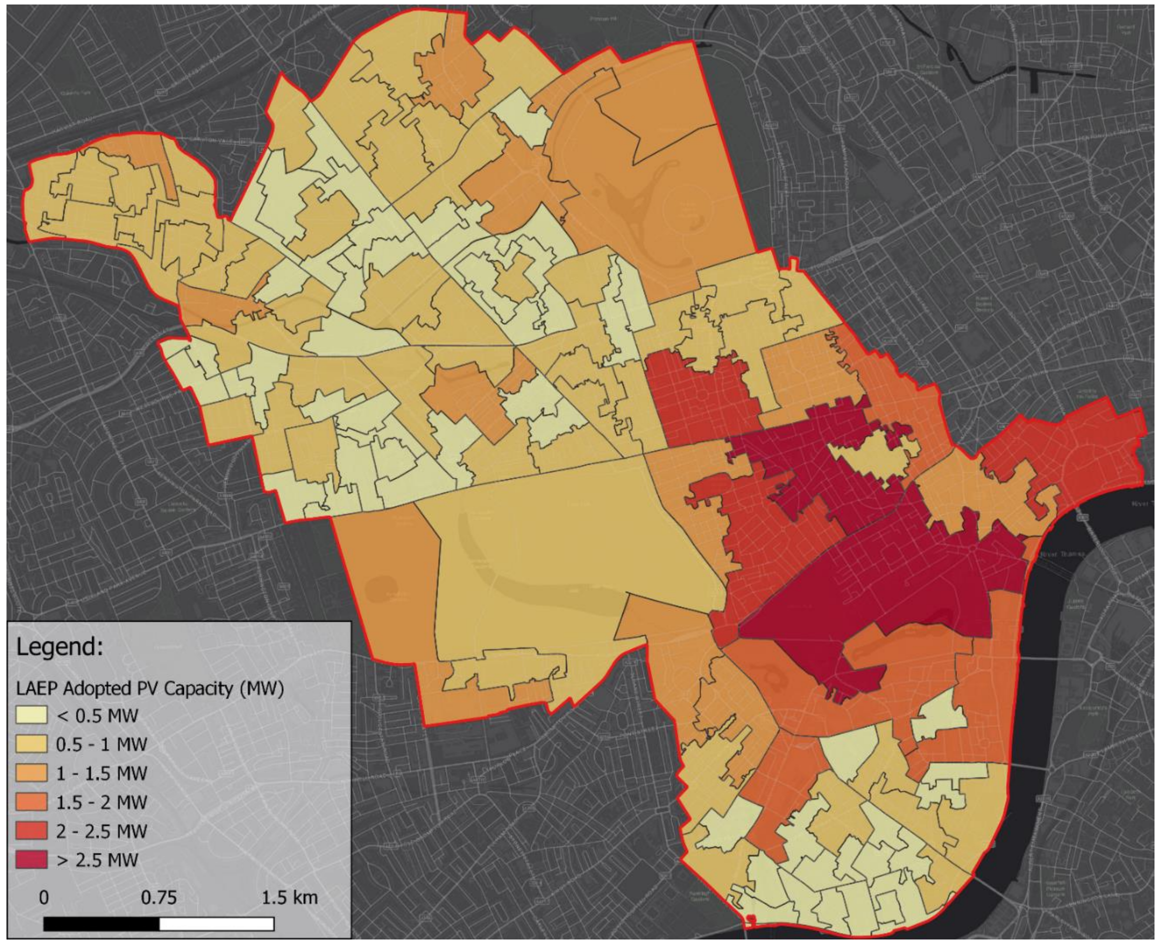


Figure 0—4 LSOA level PV deployment in the LAEP scenario

The LSOAs with the highest combined LAEP adopted solar capacities are primarily located in the east of the borough, with two LSOAs achieving over 2.5 MW of installed capacity. Another area of focus should also include the north west, with a large proportion of smaller (by area) LSOAs achieving 1-2 MW – showing a high density of potential. Key LSOA areas include Kensal Town and West Kilburn to the northwest and St James, Mayfair and Covent Garden.

To achieve the 90 MW of installed capacity by 2040, a progressive roll-out of installations would be required, with 36.5 MW (40.5%) required to be installed by 2030, 64.7 MW (71.8%) by 2035, with 90.0 MW achieved in 2040. This equates to an average rollout of 4.7 MW per year, 5.2% of the total. This deployment rate is illustrated in Figure 0—5.

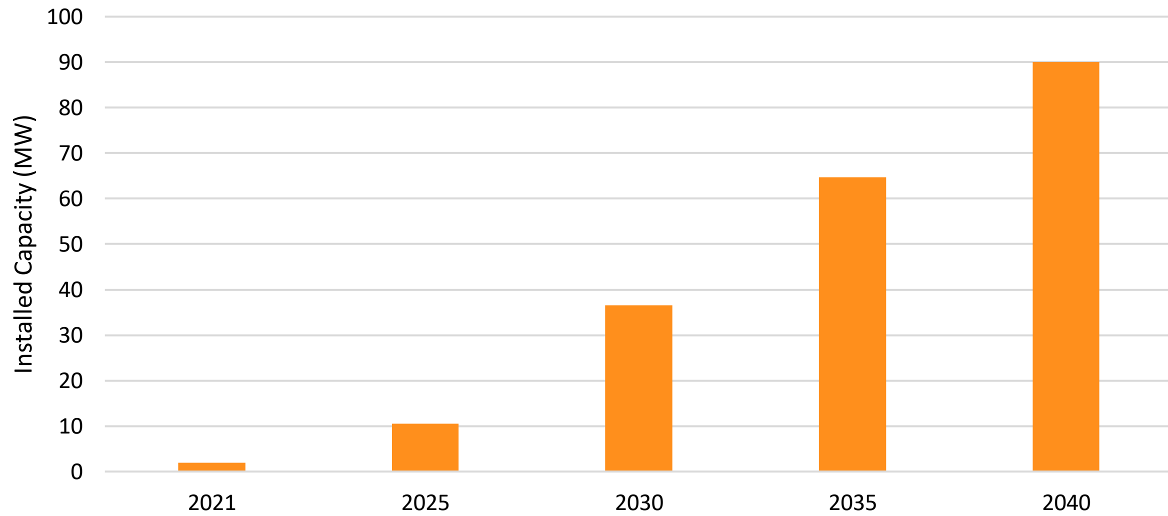


Figure 0—5 PV deployment rate for the selected LAEP

Matching generation to demand

When assessing future large-scale roll-out of rooftop solar PV generation across Westminster, examining the existing UKPN electricity network and infrastructure supplying the borough was required to analyse primary/grid substations and their headroom for additional connection of solar PV. Figure 0—6 uses a red, amber, green high-level analysis (RAG symbology) on the primary substation supply areas, whereby red indicates a very limited demand capacity and green a high level, with the individual primary substations also mapped.

As indicated in Figure 0—6 the majority of primary substation supply areas have a demand RAG of 'green' indicating a headroom of over 5%. The Carnaby St 11 kV primary substation is the only PS with a demand headroom < 0 MW however with three primary substations within the same supply area, combined they have a demand headroom over 5% making the area a RAG of 'Green'.

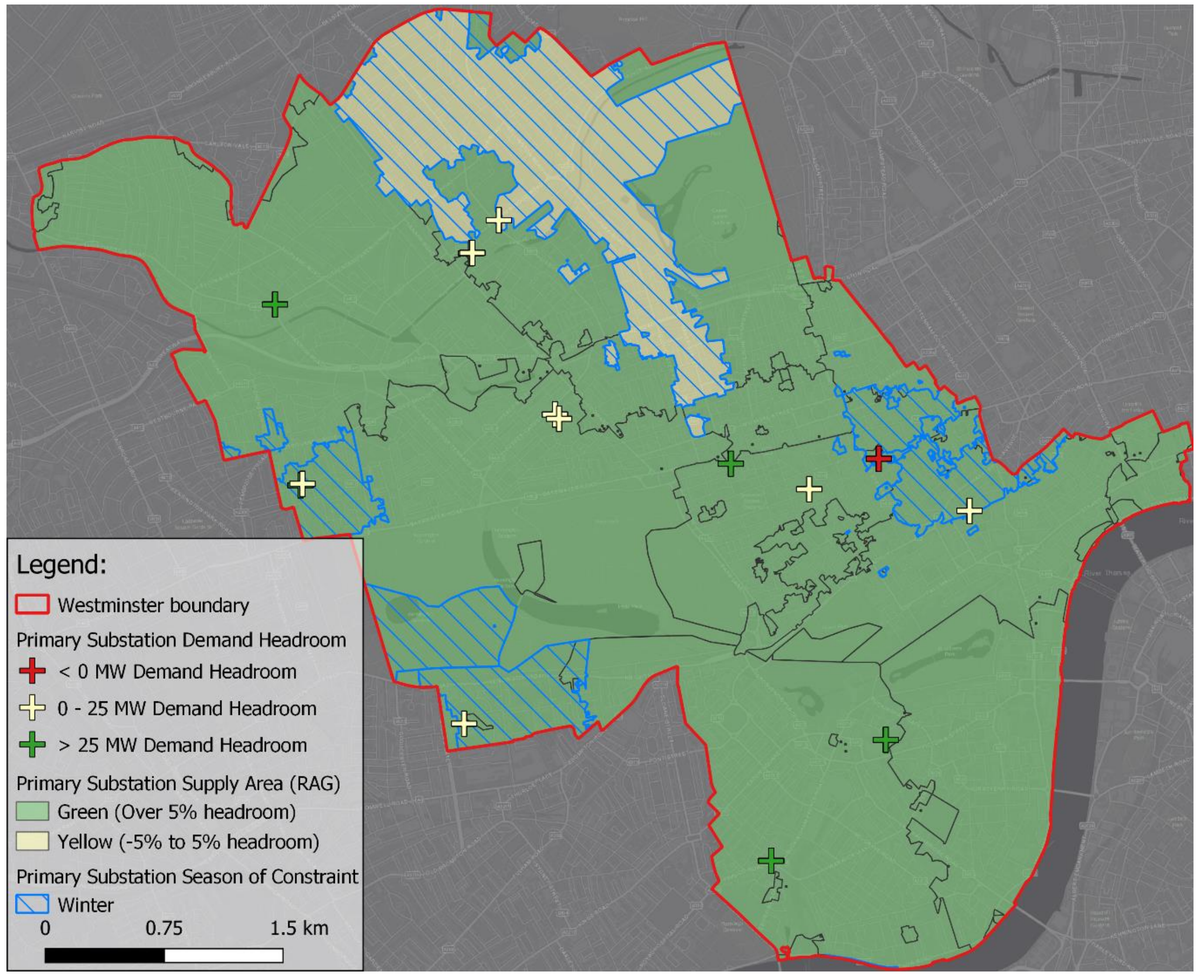


Figure 0—6 Existing primary substation capacity headroom

It should be noted that Figure 0—6 is concerned with the ability of the grid to absorb generation. Demand in urban areas tends to be the greater area of constraint, this is discussed further in section 0.

The generation of electricity via rooftop PV will be of highest in the summer months when solar radiation is the most intense. Currently, from the demand side, the supply of renewable generated electricity will be of most benefit during the summer months - when higher electricity demands are typically required for the cooling of non-domestic buildings in the borough. However, as the supply of heat shifts away from fossil fuels and electrifies in the LAEP scenario, demand patterns will likely change with electricity demand being more strongly associated with heating than is currently the case.

The deployment of rooftop solar PV areas would be of most initial benefit in substation areas with a Summer seasonal demand constraint, as PV can help balance the increased demand locally. Of the 23 primary substations, 17 of these have a season of constraint defined as Summer by UKPN. Figure 0—6 indicates the 6 areas with a season of constraint of Winter, with the remaining Summer.

Ideally where possible the power generated by PV will be used onsite. This helps realise the maximum contribution to net zero and can also result in substantial savings for the consumer.

Priority areas for PV deployment

Based on the insights above buildings for initial PV deployment are prioritised if they are supplied by a primary substation with a summer constraint. Primary substation supply areas with a season of constraint of summer covers 80% of Westminster, with 82% of the total potential PV capacity within these areas.

Solar rooftop modelling of these prioritised buildings summarised at a 100m x 100m resolution level is presented in Figure 0—7. These prioritised buildings align to a deployment potential of 201 MW (82% the total potential capacity of 245.8 MW).

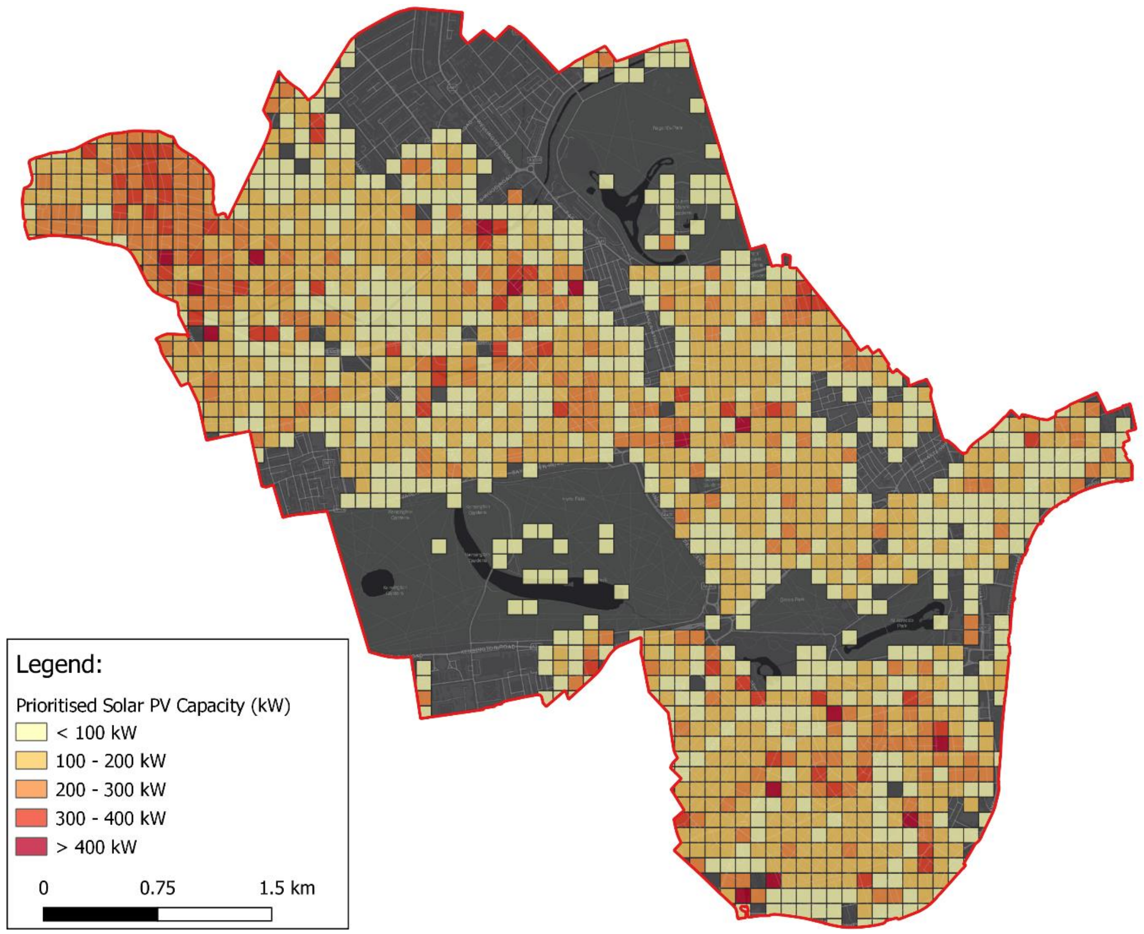


Figure 0—7 Prioritised PV deployment capacities

Analysis into the breakdown of typology sectors which achieve this deployment of 201 MW is shown in Table 0—4.

Table 0—4 Prioritised deployment

Typology	Building Counts	PV Capacity (MW)
Non-domestic	3,987	55.4
Domestic	15,492	98.8
Mixed – i.e. within the same building both typologies are present	3,025	46.8
Total	**22,504**	**201.1**

A more detailed examination of the building typologies for domestic properties is provided in Table 0—5 and for non-domestic properties in Table 0—6. For buildings with a mixed typology, within the next section, the building's demand was split 50:50 between the domestic typology and non-domestic typology – hence the numbers being elevated compared to Table 0—4

Table 0—5 Prioritised deployment - domestic

Domestic	PV Capacity (MW)	Percentage
Flat	91.0	69%
House	31.2	31%
Total	**122.2**	**100%**

Flats provide the largest potential for priority domestic PV deployment; however, they can create more complexities than houses. Blocks of flats have multiple residents and owners, which can present issues relating to ownership and deployment of PV. Also, flats are more likely to have other uses for the roof space – including air source heat pumps for heat decarbonisation. This is accounted for in the somewhat conservative assumption of roof space availability for PV.

Table 0—6 Prioritised deployment – non-domestic

Non-domestic	PV Capacity (MW)	Percentage
B1 - Offices and Workshops	28.9	36.6%
A1/A2 - Retail and Financial Services	21.6	27.5%
D1 - Non-residential Institutions	10.7	13.5%
A3/A4/A5 - Restaurants and Cafes	6.5	8.3%
C1 - Hotels	3.7	4.7%
D2 - General Assembly	2.8	3.5%
C2 - Residential Institutions	2.3	3.0%
Other	1.5	1.9%
B8 - Storage or Distribution	0.4	0.6%
B2-B7 - General Industrial	0.4	0.5%
Total	**78.8**	**100%**

Offices and retail are the two most dominant sectors in terms of PV potential. These typologies are two where cooling demand is common, thus aligning well to PV generation profiles.

The geographical visualisation of prioritised deployment (Figure 0—7) provides opportunities to visually identify potential intervention areas for deployment. Three primary priority areas have been outlined based upon prioritised deployment within 100m x 100m areas of a combined installed capacity greater than 200 kW (see Figure 0—8).

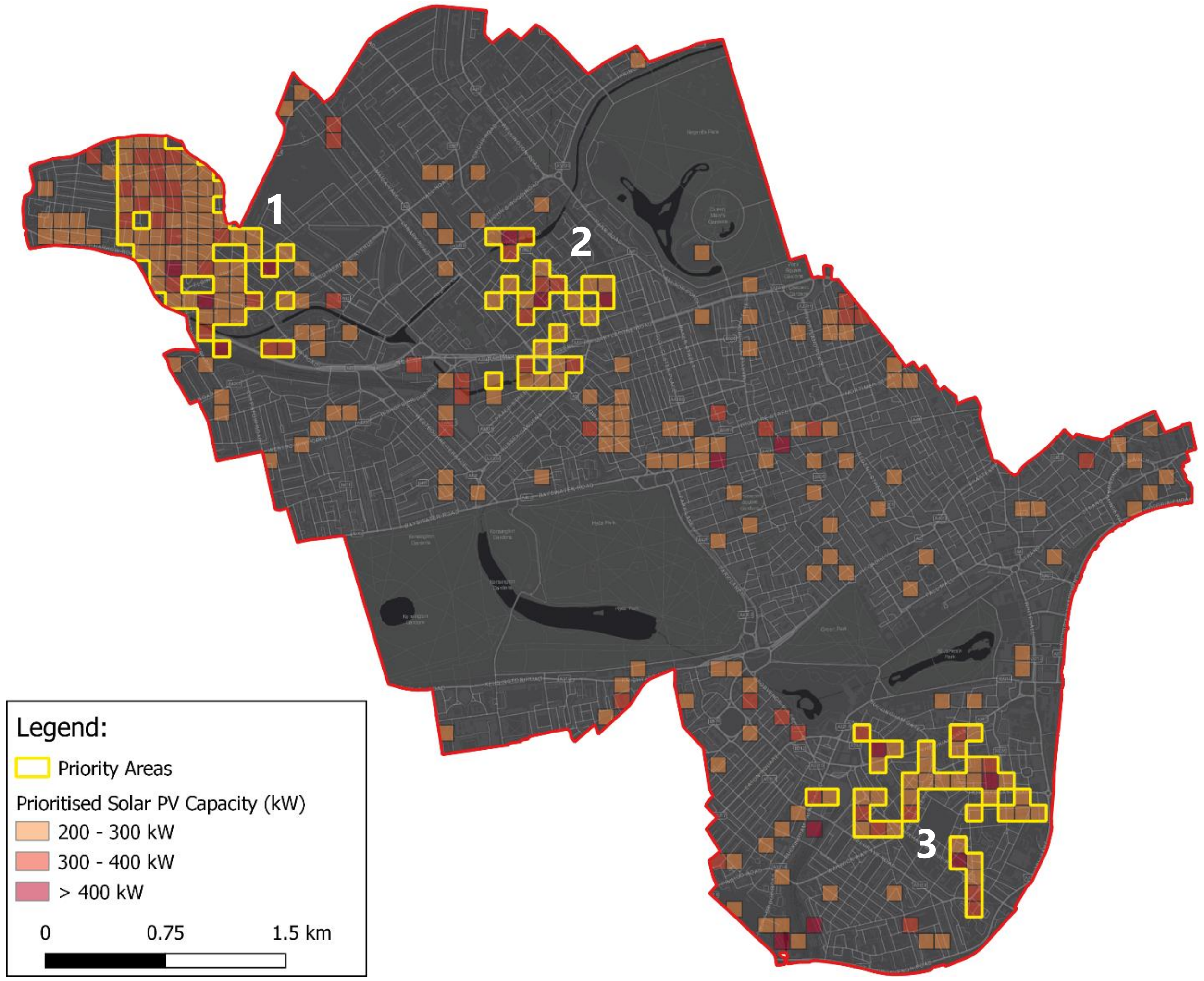


Figure 0—8 Prioritised deployment over 500 kW per 100m grid

1. West Kilburn / Maida Hill -Residential area consisting primarily of low rise terraced houses.
2. West Marylebone - Located to the West of Marylebone Station. Primarily Residential with mid/high rise units with various schools nearby such as King Solomon Academy and Abingdon School and College.
3. Millbank - Mix of primarily mid-rise rise residential and commercial buildings. Key buildings e.g. Home Office, MI5, Channel 4 Television, Millbank Academy.

WCC PV opportunities

The filtering of buildings to identify priority areas also focuses on WCC buildings and their opportunities. An updated 100m x 100m resolution of prioritised WCC buildings and/or buildings within WCC land parcels is shown in Figure 0—9. These prioritised buildings have a 43.5 MW potential.

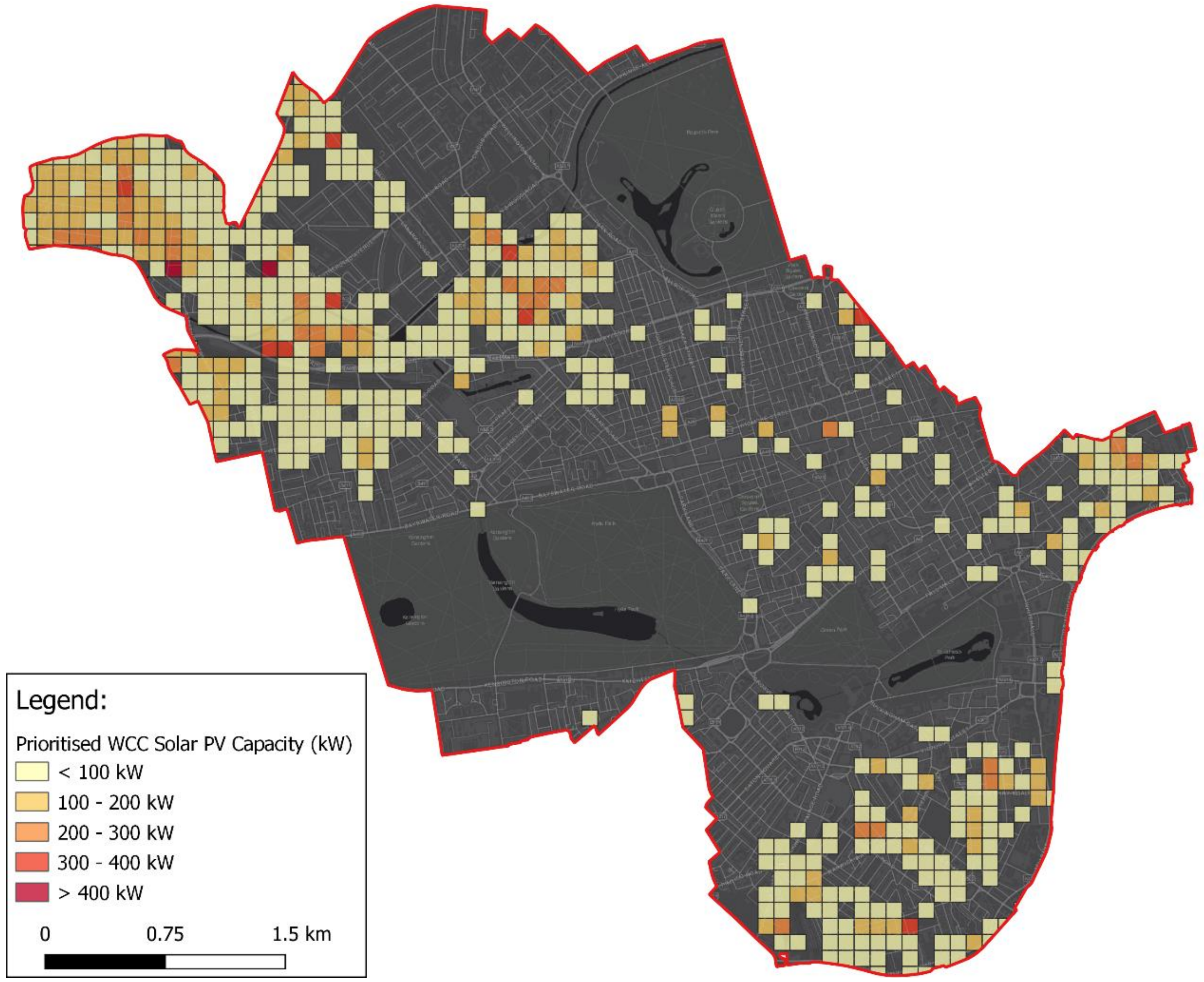


Figure 0—9 WCC prioritised deployment

The individual capacities of WCC buildings are summarised within Figure 0—10.

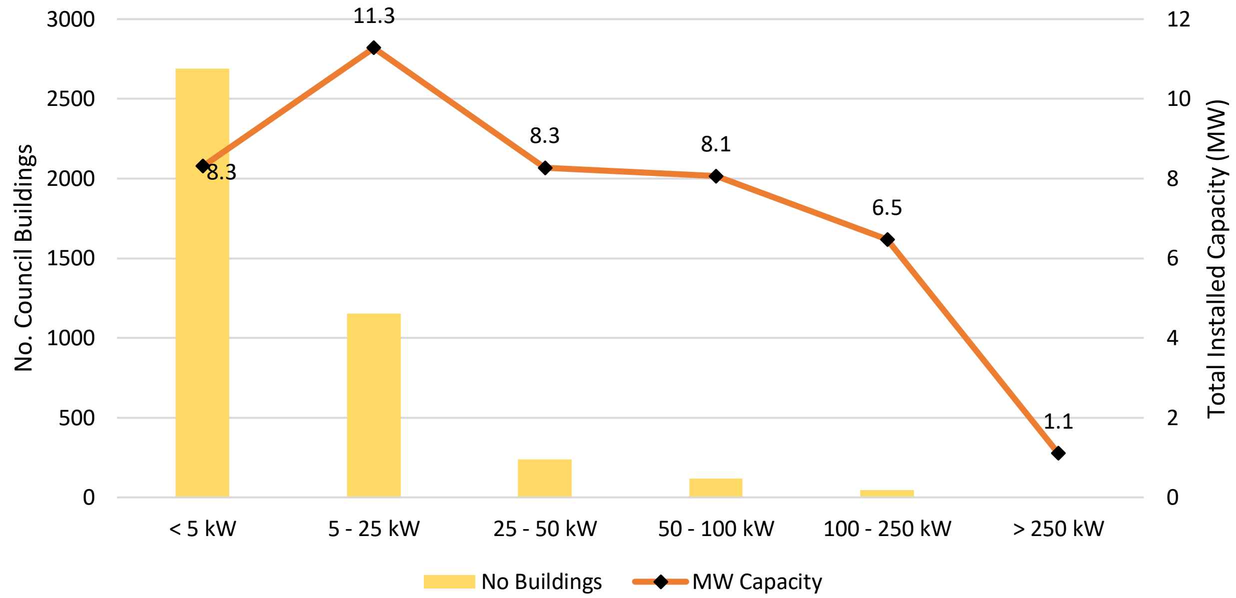


Figure 0—10 Potential solar array sizes on WCC buildings

Corresponding to the typology analysis undertaken for all priority deployment buildings, the analysis on prioritised WCC buildings and/or buildings within WCC land parcels which achieve this deployment of 43.5 MW is shown in Table 0—7.

Table 0—7 Deployment on WCC assets by domestic and non-domestic building types

Typology	Building counts	PV capacity (MW)
Non-domestic	419	9.7
Domestic	3,533	26.4
Mixed – i.e. within the same building both typologies are present	295	7.4
Total	**4,247**	**43.5**

The largest opportunities identified on WCC assets were:

- Pimlico Academy - 454 kW capacity potential
- Paddington Academy - 452 kW capacity potential
- Queen Elizabeth II Jubilee School - 288 kW capacity potential
- Westminster Academy - 246 kW capacity potential
- DEFRA building - 223 kW capacity potential
- Office for National Statistics – 221 kW capacity potential
- Pimlico Place (housing) – 214 kW capacity potential
- Burne House – 188 kW capacity potential
- Queen Mother Sports Centre – 182 kW capacity potential
- Westminster City Council Frampton St – 174 kW capacity potential
- Lanark Road (housing) – 172 kW capacity potential
- 10 Portman Square – 167 kW capacity potential
- 43 Wigmore Street – 163 kW potential capacity

Clearwell Drive (housing) – 161 kW potential capacity

Kings College London (Kings Building) – 159 kW potential

It should be noted that blocks of flats that are owned by WCC are likely to be less complex for PV deployment than for standard blocks. The locations of these 15 sites with the highest potential capacities are presented in Figure 0— with their capacity ranking labelled for cross referencing. Please note that Bourne Terrace (Block 17-157) was within the top 15 WCC opportunities, however, this has not been included due to the recent installation of 87 kW of rooftop PV on the building roof.

Figure 0—15 highest PV capacity opportunities on WCC buildings

PV costs and support

Solar PV has recently undergone substantial fluctuations in price (see DESNZ 2023[31]). Currently larger systems (10-50 kW) are averaging ~55% of the price of smaller typical domestic systems (up to 4 kW). The current cost for a 4 kW system is £2,237 which is a record high and likely to reduce, particularly if bulk purchase of panels is achievable in Westminster. A price of £2000 per kW is assumed. This is somewhat elevated, particularly given that larger schemes will be included that are currently averaging £1226 per kW. This is to account for the integration of battery technology into some of the systems. This allows greater flexibility and revenue.

The total spend on PV and integrated battery technology is therefore £179 million for the LAEP scenario. The return on investment (ROI) is promising in the LAEP analysis, being ~7.5 years in most instances (with systems generally having at least a 20-year lifecycle). This value is generally in line with industry figures but will vary on a case-by-case basis and is influenced by a variety of wider factors – including the relative price of grid electricity.

[31] DESNZ, 2023: Solar photovoltaic (PV) cost data. https://www.gov.uk/government/statistics/solar-pv-cost-data

Energy Infrastructure

Existing energy infrastructure

This section examines the gas and electricity networks in Westminster. Given that hydrogen was excluded from the scenario shortlisting the focus is on electricity infrastructure. However, the gas network provide a useful context so are discussed in brief.

Gas network

Cadent Gas are the Distribution Network Operator (DNO) in Westminster. To support this study they provided high resolution data to enhance the accuracy of the baseline demands. They also highlighted that the vast majority of pipework (at low and medium pressure) has been switched to plastic under the iron mains replacement programme, enabling an increased share of hydrogen within the network.

The gas network is widely integrated There is a total of 85,128 domestic MPRNs and 7,039 non-domestic MPRNs in Westminster, supplied by Cadent. MPRNs refer to Meter Point Reference Number and is a unique number used to identify gas services within buildings. The large number of MPRNs shows that the gas network is widely integrated across Westminster. Subnational statistics from 2021[32] estimate a total gas demand of Westminster of ~3,364 GWh, split by Domestic (28%) and Non-Domestic (78%), a distribution of this demand across Westminster is provided in Figure 0—1.

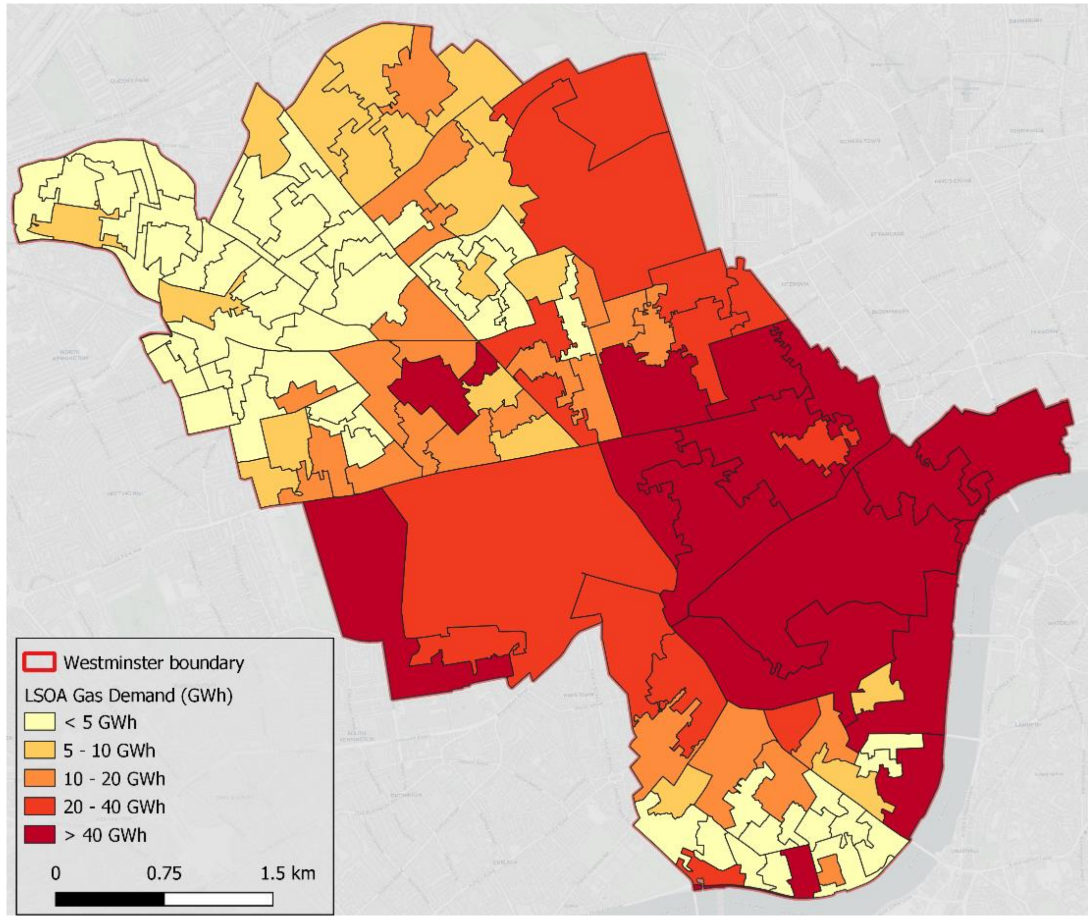


Figure 0—1 LSOA Gas Demand in Westminster

Westminster's gas demand for buildings is the 16th highest in the UK and the largest in London, it is also the 4th highest in the UK per capita. This dependency on gas highlights the challenge of switching towards electrified heating solution. Although gas demand is high in domestic properties, as previously highlighted, it is the non-domestic demand that presents the largest share. The distribution of demand in Figure 0—1 shows demand is concentrated in the non-domestic dominated areas of Westminster, most notably the West End. As discussed in sections 0 and 0 the buildings in this area of the gas network are going to be some of the most challenging to switch to low carbon solutions.

Whilst the majority of gas demand is used for space and water heating, a notable portion is also used for cooking, assumed to be ~2% based on national figures[33]. This ~67 GWh/yr is considered in the LAEP but as a small component it is not a focus. However, it is worth noting that suitable electric alternatives are already available for most situations with little or no impact on user experience.

Electricity network

Subnational statistics from 2021[34] estimate a total electricity demand of Westminster of ~3,026.7 GWh, split by domestic (15%) and non-domestic (85%). UK Power Networks (UKPN) are the Distribution Network Operator (DNO) for electricity in Westminster.

There is a total of 13 UPKN primary substations located in the boundary of Westminster, primary substations are the key substations for distribution of large volumes of electricity around a local authority. All 13 of the primary substations currently have demand headroom, ranging from 3.4 to 73.2 MVA. The location of these is provided in Figure 0—2. The capacity of substations is explored as percentage of current demand. A high percentage show a high capacity compared to present, whilst a low percentage (10% and below is a good indication) indicates relatively little additional electricity demand can be added without the need for network reinforcement.

32 https://www.gov.uk/government/statistics/regional-and-local-authority-gas-consumption-statistics
33 DESNZ, 2023: Energy consumption in the UK 2023. https://www.gov.uk/government/statistics/energy-consumption-in-the-uk-2023
34 https://www.gov.uk/government/statistics/regional-and-local-authority-electricity-consumption-statistics

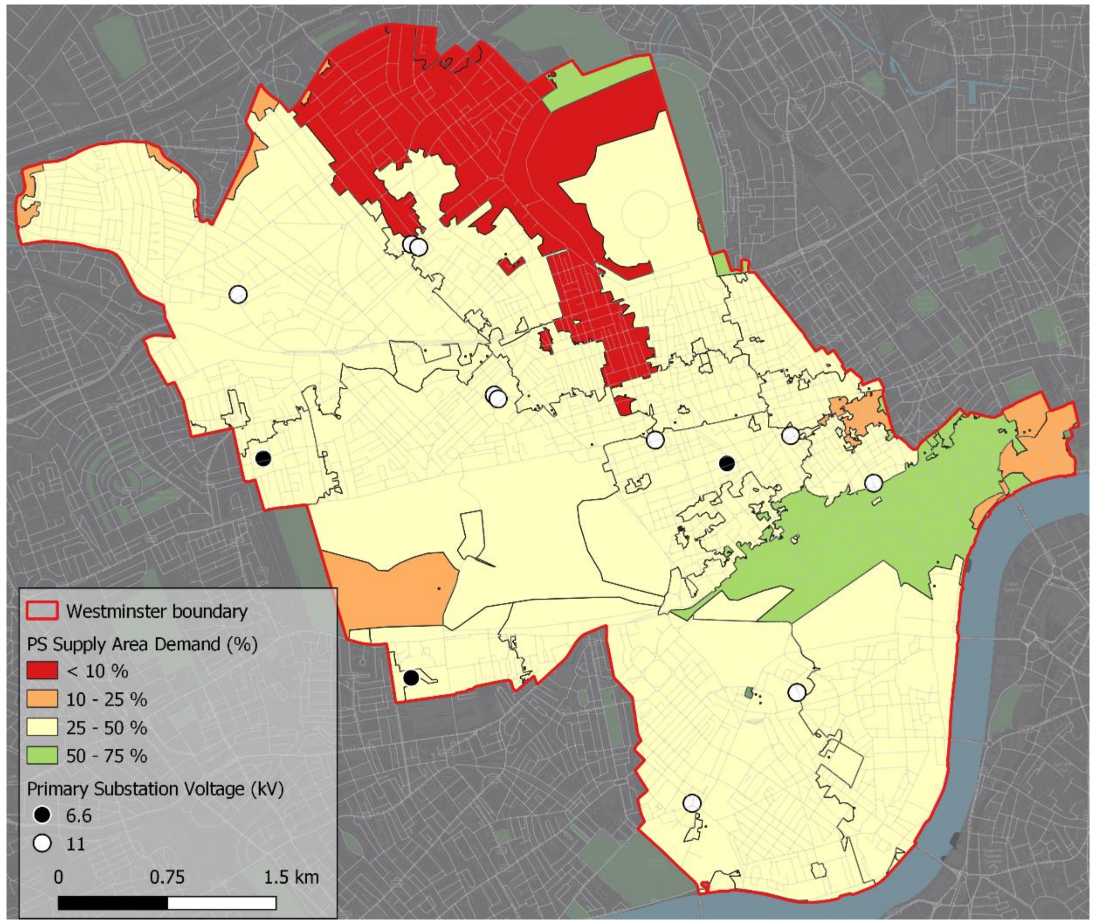


Figure 0—2 Primary Substation headroom as percentage of current demand – shown at supply area.

Electricity network infrastructure does not align to political boundaries. This is illustrated by 27 different primary substation supply areas within Westminster, meaning 14 primary substations supply power to Westminster but are outside the local authority boundary. The characteristics of all 27 substations is provided in Table 0—1.

Table 0—1 Primary substation details

No.	Primary substation	Voltage	Demand %	Season of Constraint	PS Location
1	Aberdeen Pl A	11 kV	29.9%	Summer	**Within Borough**
2	Aberdeen Pl B	11 kV	1.6%	Winter	**Within Borough**
3	Amberley Rd	11 kV	36.6%	Summer	**Within Borough**
4	Bloomfield Place	6.6 kV	34.9%	Summer	**Within Borough**
5	Carnaby St	11 kV	31.4%	Winter	**Within Borough**
6	Duke St B	11 kV	38.0%	Summer	**Within Borough**
7	Ebury Bridge	11 kV	42.8%	Summer	**Within Borough**
8	Fisher St B	11 kV	58.1%	Winter	Outside Borough
9	Hyde Park Estate A	11 kV	28.4%	Summer	**Within Borough**
10	Hyde Park Estate B	11 kV	42.1%	Summer	**Within Borough**
11	Imperial College	6.6 kV	38.7%	Summer	**Within Borough**
12	Kimberley Rd	11 kV	16.8%	Summer	Outside Borough
13	Kingsway	11 kV	13.4%	Summer	Outside Borough
14	Leicester Sq	11 kV	50.1%	Summer	**Within Borough**
15	Limeburner Ln	11 kV	79.6%	Summer	Outside Borough
16	Lithos Rd A	11 kV	6.4%	Winter	Outside Borough
17	Lombard Rd B	11 kV	31.1%	Summer	Outside Borough
18	Longford St B	11 kV	39.6%	Summer	Outside Borough
19	Montford Place B	11 kV	32.5%	Winter	Outside Borough
20	Moreton Street	11 kV	39.8%	Summer	Outside Borough
21	Moscow Rd	6.6 kV	41.9%	Winter	**Within Borough**
22	Old Brompton Rd B	11 kV	44.9%	Winter	Outside Borough
23	Shorts Gdns	11 kV	13.8%	Summer	Outside Borough
24	Georgiana St	11 kV	58.0%	Summer	Outside Borough
25	Georgiana St	11 kV	58.0%	Summer	Outside Borough
26	Victoria Gdns	6.6 kV	24.8%	Winter	Outside Borough
27	Victoria St	11 kV	82.8%	Summer	**Within Borough**

Of these 27 primary substations supply areas, 26 have a demand headroom RAG of "Green" with (Over 5% Headroom), with 1 area being Yellow (-5% to 5% headroom). The critical peak season (season of constraint) of these supply areas is split between both Summer and Winter, with 19 having a seasonal constraint of Summer and 8 with Winter (Figure 0—3).

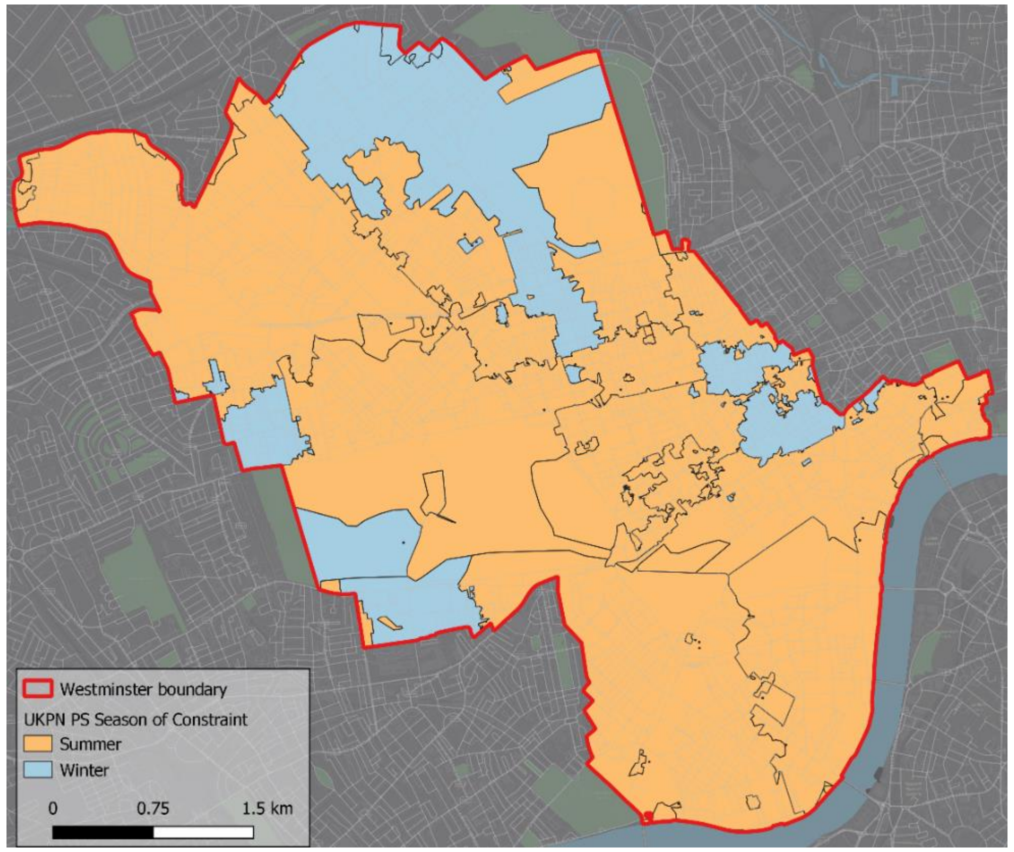


Figure 0—3 Primary Substation – Seasonal Constraint

This shows that with mainly gas providing heat the cooling demand in the summer in Westminster is currently the dominant factor in determining peak demand on the network. The analysis undertaken in the LAEP indicates this will change with the electrification of heat demand, even with increased cooling demand.

Whilst there are some seasonal constraints there are not currently flexibility issues identified in Westminster, this is illustrated in Figure 0—4.

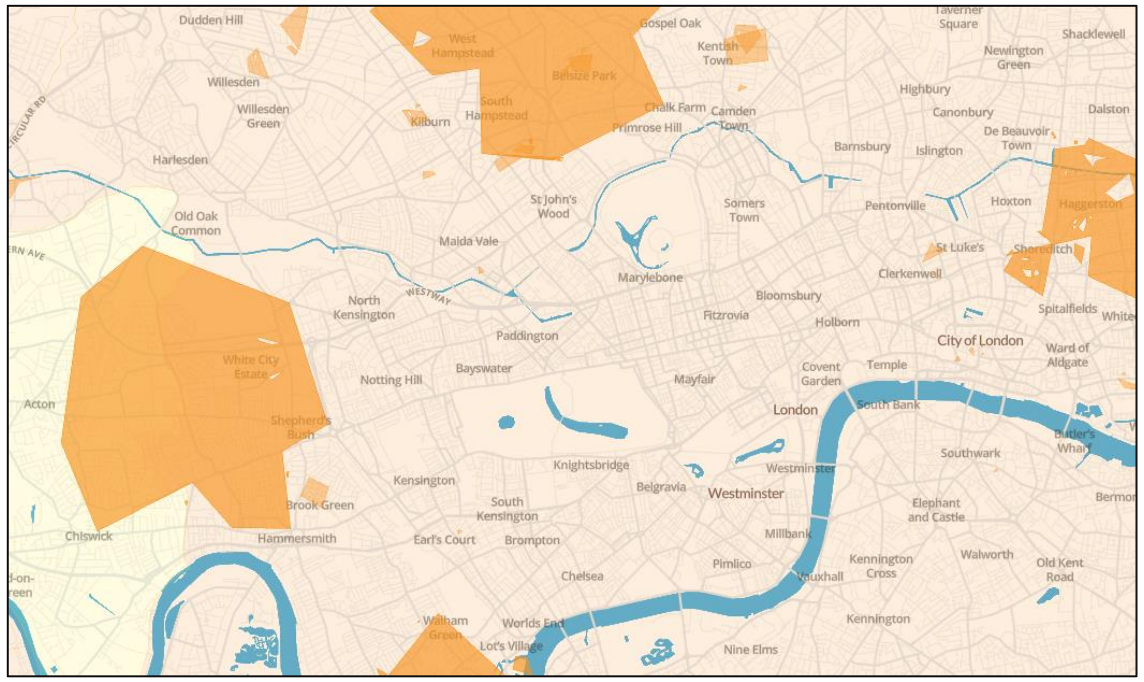


Figure 0—4 Flexibility market areas (highlighted by the orange polygons) identified on the Picloflex website[35].

Picloflex is a website which highlights the opportunities for supply of flexibility to UKPN for an agreed fee. There are three key offerings for flexibility in the UKPN area[36], outlined in Table 0—2, it should be noted that smart enabling technology is required to make these flexibility services more widely available.

Table 0—2 Summary of UKPN flexibility services that can be participated in.

Service	Description	Application in LAEP context
Demand turn up HV & LV (for both low voltage and high voltage assets, i.e. all connections)	In times of excess generation demand is increased. In the current system excess generation is often mitigated by curtailment or reduction of flexible generation connection, the service thus helps reduce payments going to generators to stop producing power. In these times of excess generation, the grid will normally have a large share of renewables, meaning use the electricity will tend to have lower associated carbon emissions.	A cheap time to charge batteries and storage systems, essentially receiving payment for charging. As well as electrical storage this can also include charging thermal stores. For example, if a heat pump system includes a hot water tank, which the heat pump could charge in times of excess generation. The same principle, at a larger scale, exist for heat networks – where large thermal stores and electric heating technologies present multi MWs of flexibility.
Demand reduction HV & LV (for low voltage and high voltage assets, i.e. all connections)	This is set up to help reduce demand at times of peak. The flexibility provider must be able to reduce demand from a historic baseline for at least 30 minutes.	This can either be not using a technology such as charging EVs (although as this is based on a historic baseline, opportunities for EV charging are likely to be somewhat limited) or through reducing demand by use of onsite generation or batteries.
Demand reduction LV (low voltage assets only, i.e. only small connections – such as domestic)	This is similar to the demand reduction for HV & LV but is purely focused for smaller electricity users.	Likely to be the most accessible to residents. Helps enable deployment of heat pumps and EV chargers at a local level without grid reinforcement. Opportunities are similar to the HV & LV context. Switching from inefficient direct electric heating to more efficient electric heating technology could in some contexts also enable the reduction required for participation.

Whilst there are currently some large flexibility opportunities around Westminster there are not any large opportunities in Westminster itself – illustrating that the grid is currently relatively stable in the area. However, as the technologies in the LAEP are deployed this will start to stress the grid increasing the need for flexibility services. The need for flexibility will generally align with timing of increased electrification. Priority areas for specific technologies therefore also give an indication of where the needs for flexibility are likely to arise. It is important to note that there is a minimum capacity required to contribute to these flexibility offerings, however, small capacities can be aggregated. Consequently, there is an opportunity for WCC (particularly if they own a large number of assets in an area) to aggregate flexibility offerings to reach the required threshold.

Transport

Transport is included in the energy infrastructure section of the LAEP as the main implications of transport decarbonisation on Westminster's energy system is an increase in electricity demand, with the increased electricity infrastructure required to meet this increased demand. With Transport for London being integral to public transport in London and a strong set of Westminster specific policies, including active travel encouragement, transport is a relatively small element of the LAEP analysis. For additional context the majority of Westminster's energy demand comes from buildings (~6 times that of transport currently), the relative share from transport decreases further with the switch to electric vehicles. This is because electric engines are at least three times the efficiency of standard combustion engines.

As such with the exception of the reduction in vehicle ownership the LAEP scenario aligns strongly with UKPN Distributed Future Energy Scenario.

Existing transport system

Transport, especially public transport is key to Westminster. Westminster houses 32 tube stations, three Elizabeth Line stations (Paddington, Bond Street and Tottenham Court Road), ~495 bus stops, 73 day bus routes[37]. It also includes Victoria train station, the second busiest in the UK. This public transport is a key enabler for decarbonisation, reducing reliance on personal vehicles. However, it is not the focus of the LAEP – as it is an energy rather than transport piece of work.

The LAEP will focus on locally based transport, covering cars, lights goods vehicles (LGVs), buses, coaches and heavy goods vehicles (HGVs). This is because it cannot be expected for the LAEP area to offset national transport emissions of vehicles travelling through. There are also significant rail and TfL tube routes in the area, however, they are not considered in the analysis as they are better suited to national or sub-national rather than local strategies.

Vehicle Statistics

Westminster has a 2020 vehicle count of ~56,500[38], with 87% of these being cars, however total vehicle ownership and cars have both been reducing in recent years. Cars within Westminster resulted in a total 271 million vehicle miles of transport also in 2020, on average ~6,700 per car with all road traffic equating to 398 million vehicle miles. A breakdown of the count of different vehicle types is provided below:

- Cars = 87%
- Buses and Coaches = < 1%
- HGVs = < 1%
- LGVs = 6%
- Motorcycles = 4%
- Other Vehicles = 2%

This highlights, as is typical for most local authorities, that cars and LGVs are the focus for decarbonisation.

[35] https://picloflex.com/dashboard
[36] For details please see https://dso.ukpowernetworks.co.uk/flexibility
[37] https://tfl.gov.uk/info-for/boroughs-and-communities/westminster
[38] https://www.gov.uk/government/statistical-data-sets/vehicle-licensing-statistics-data-files

Electric Vehicles

Electric vehicles (EV) utilise a rechargeable battery which uses electricity in place of a petrol or diesel engine. There are a total of ~13,500 electric vehicles[39], which equates to ~23% of Westminster's vehicles, up from ~8,000 and 14% respectively in 2021[40]. The majority of these (94%) are EV cars, with a breakdown of electric vehicles within the borough presented in Table 0—3.

Table 0—3 Electric Vehicle Breakdown within Westminster[41][42]

Local Authority	Bus	Motorcycles	Taxi	PHV	Cars	Vans	TOTAL
Westminster	10	8	104	371	12,635	369	13,497

The geographic distribution of total number of electric vehicles by Lower Layer Super Output Areas (LSOA) is presented in Figure 0—5 EV numbers by LSOA.

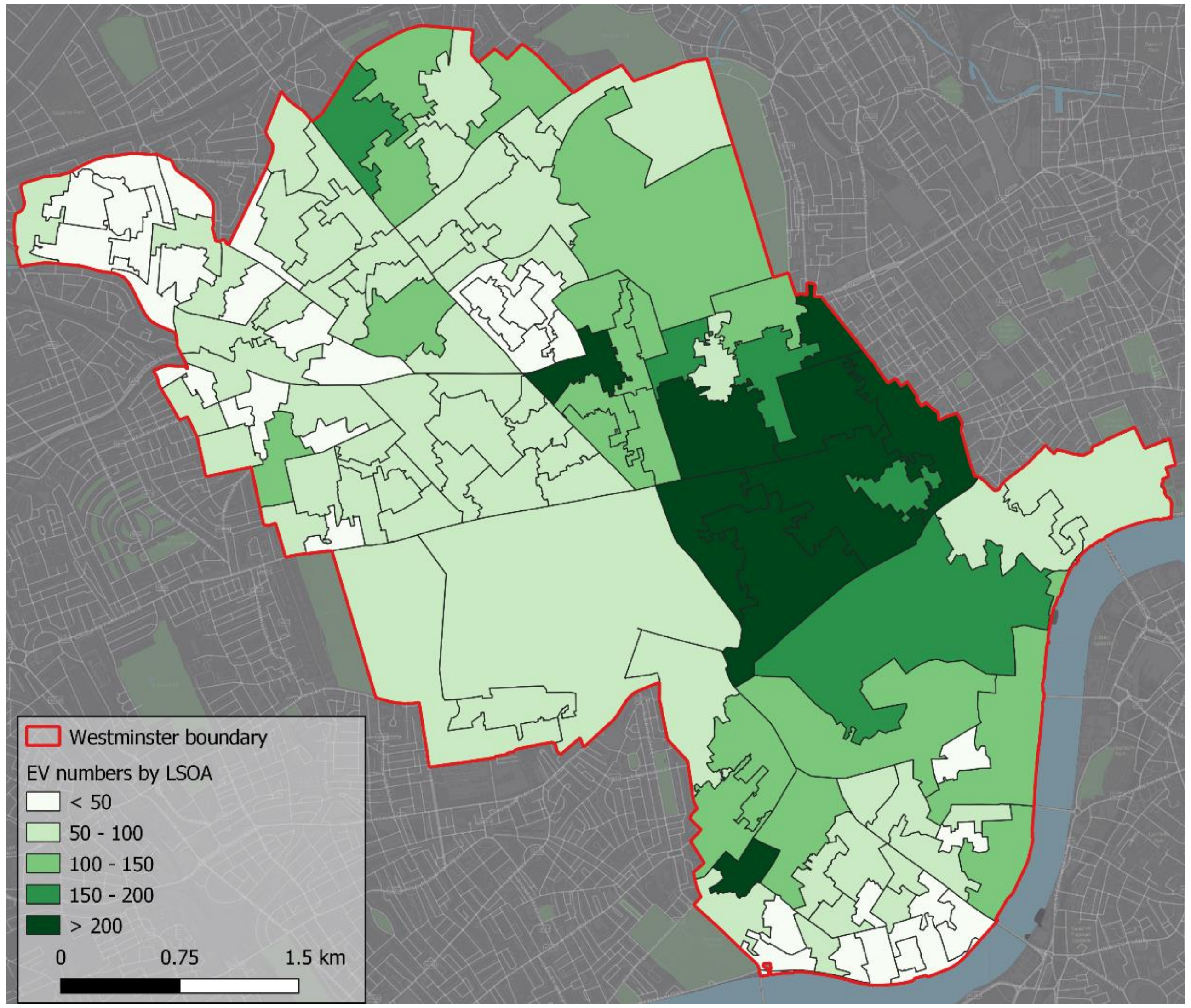


Figure 0—5 EV numbers by LSOA

Westminster has a total of 2,500[43] on street electric vehicle charge points[44], ranging from 5kW to over 50kW, the counts for different capacities of charger are:

- < 5 kW = 2,331
- 5 – 50 kW = 122
- 50+ kW = 47

These chargers have an installed capacity of 13.3 MW[45].

The existing electric vehicles charging capacity by LSOA across Westminster is presented in Figure 0—6.

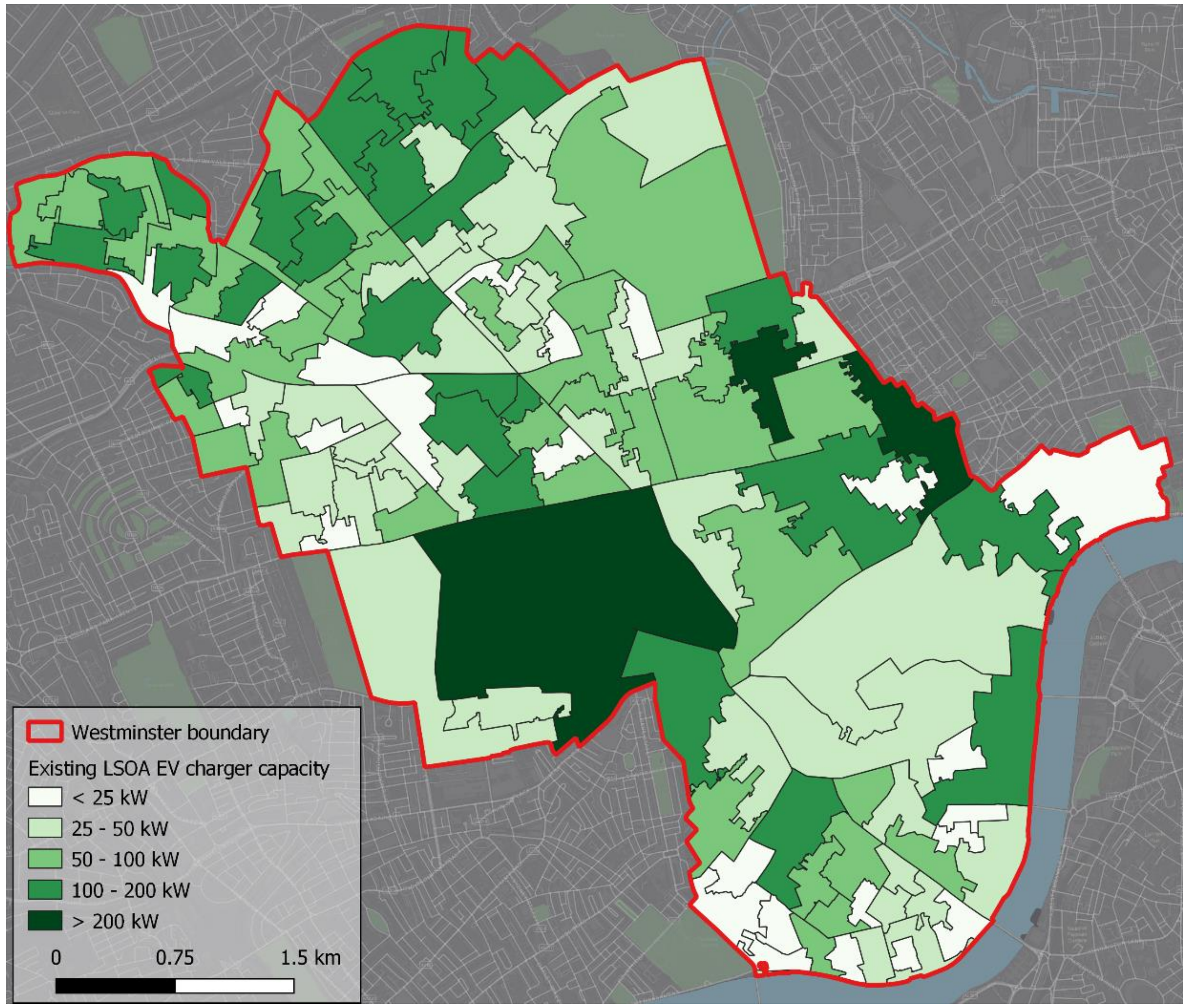


Figure 0—6 Existing EV charger capacity by LSOA

[39] Local authority data: Electric vehicles and charging points (parliament.uk)
[40] https://www.ukpowernetworks.co.uk/our-company/dfes-2022
[41] https://www.ukpowernetworks.co.uk/our-company/dfes-2023
[42] Local authority data: Electric vehicles and charging points (parliament.uk)
[43] Electric vehicles | Westminster City Council
[44] Equivalent data for off-street private charge points is less available in a consistent form at the Westminster scale, however, UKPN's data hub is increasingly improving capture of the data.
[45] https://www.gov.uk/guidance/find-and-use-data-on-public-electric-vehicle-chargepoints

Technology choice

The government has banned the sale of new petrol, diesel and hybrid vehicles from 2035. Electric vehicles (EVs) on their way to becoming the standard choice for most vehicles switching away from fossil fuels, with a minor share of hydrogen fuelled vehicles for some larger road vehicles (i.e. coaches, buses and HGVs) still seen in some scenarios. Refuelling systems will also transition from current centralised solutions (i.e. petrol stations), towards more distributed household, car park and workplace charging.

This modal shift in transportation will result in increased efficiency of the transport sector in relation to energy usage. Existing internal combustion engines (ICEs) are very inefficient converting 12%–30% of fuel energy in petrol vehicles. Electric vehicles however typically convert 77-80%[46] of the electrical energy from the grid to power at the wheels.

Residential parking

In the LAEP scenario by 2040, 98% of cars will be EVs, compared to 14% currently. The transitional shift to EV uptake, will result in a substantial requirement for residential charging infrastructure at a household level.

Residential vehicles numbers (and associated mileage) will however reduce compared to existing numbers by 27% (~53000[47] to ~38000), due to a higher uptake of public transport and lower levels of car ownership. The 98% proportion of EV cars will therefore result in a total number of residential EVs of ~38,250, with current numbers around ~13,500[48] (also including PiHs), a uniform increase of 1,450 EVs per year from 2023.

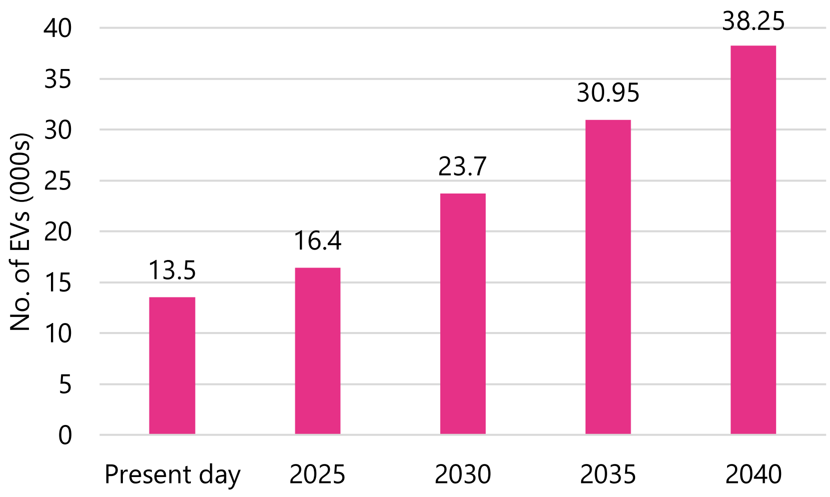


Figure 0—7 Number of electric vehicles at 5-year intervals to 2040

Using existing EV numbers and the current EV charger counts, every two chargers will supply 9 EVs. Up-scaling this to 2040 EV figures of 38,266, a total number of residential EV chargers required are 12,550. The deployment rate of these is presented if a uniform uptake of EVs occurs.

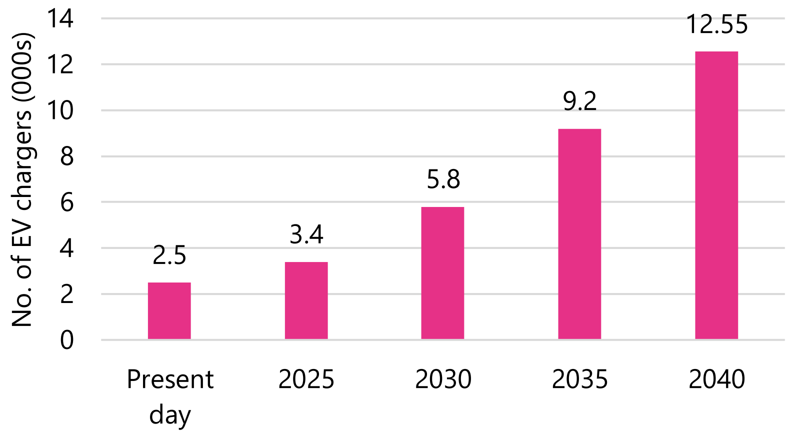


Figure 0—8 Number of EV charge points at 5-year intervals to 2040

This high number of EV chargers will generate a total installed capacity of 45.5 MW (compared to the 13.3 MW currently), which will impact existing electricity infrastructure and current headroom. The assumed average charge capacity is 5.3 kW. The distribution of residential EV charger capacity across Westminster is provided in Figure 0—9

[46] https://www.ucl.ac.uk/bartlett/news/2021/aug/energy-efficiency-first-fuel
[47] Department for Transport, 2023: VEH9901: Licensed road using cars and light goods vehicles by local authority, body type, fuel type, CO2 band, keepership, and year of first registration. https://www.gov.uk/government/statistical-data-sets/vehicle-licensing-statistics-data-tables
[48] Local authority data: Electric vehicles and charging points (parliament.uk)

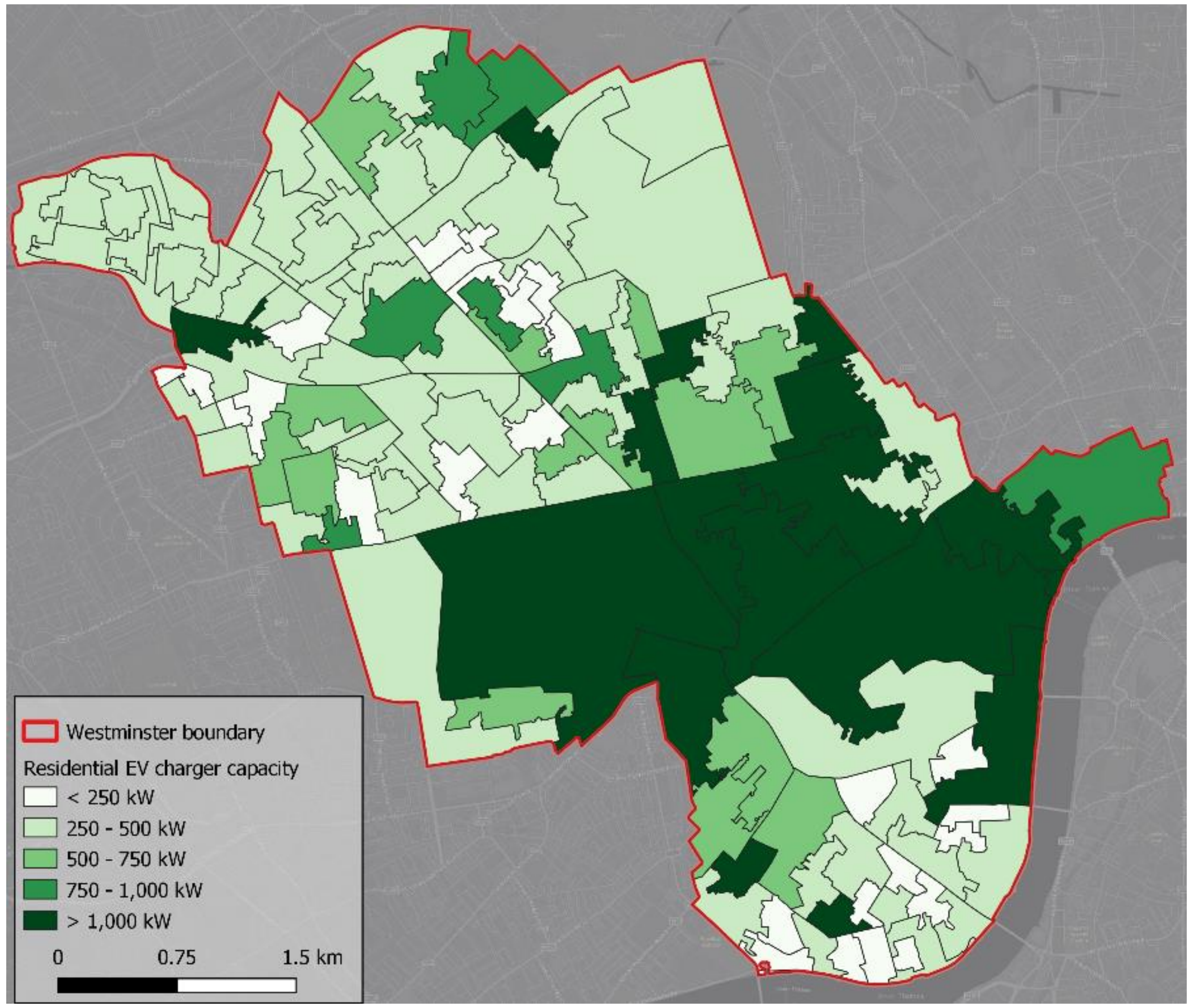


Figure 0—9 Residential EV charger capacity per LSOA – Stretch 2040

Most of the charger capacity is within the 'central belt' of Westminster, encompassing areas such as Mayfair and St James. Unsurprisingly the majority of residential EV charger requirements within Westminster will be on-street charging infrastructure due to low numbers of off-street parking from the dense urban environment within the borough. This on street parking provision is more likely to fall within direct local government control and can be a useful earlier enabler of EV adoption. Integration of EV chargers within existing street lighting infrastructure is a common practice in urban environments for on-street parking, due to the ease of integration into the power supply as well as limiting overcrowding of on-ground infrastructure.

The increased capacity in electricity demand required by the increasing numbers of electric vehicles is presented in Figure 0—10.

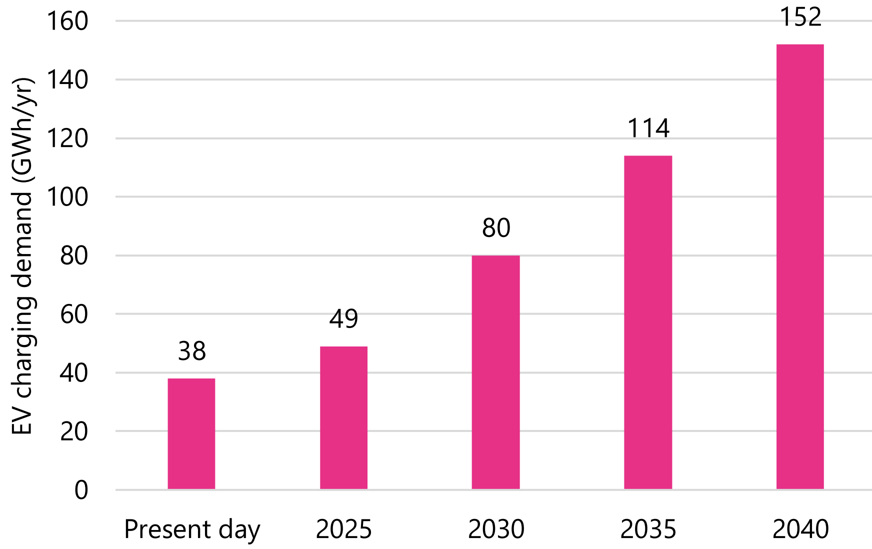


Figure 0—10 Electricity demand increase due to electrification of cars

Car parks

Car parks present an excellent opportunity for early deployment of EV chargers to charge the cars in the car park. Within Westminster 68 car parks[49] have been identified, with a combined 9,846 spaces[50] between them. Four of the largest car parks have a combined 2,150 spaces with these being:

- Euro Car Parks - The Mayfair Car Park
- Q-Park Oxford Street
- Chiltern Street Car Park
- Q-Park Victoria

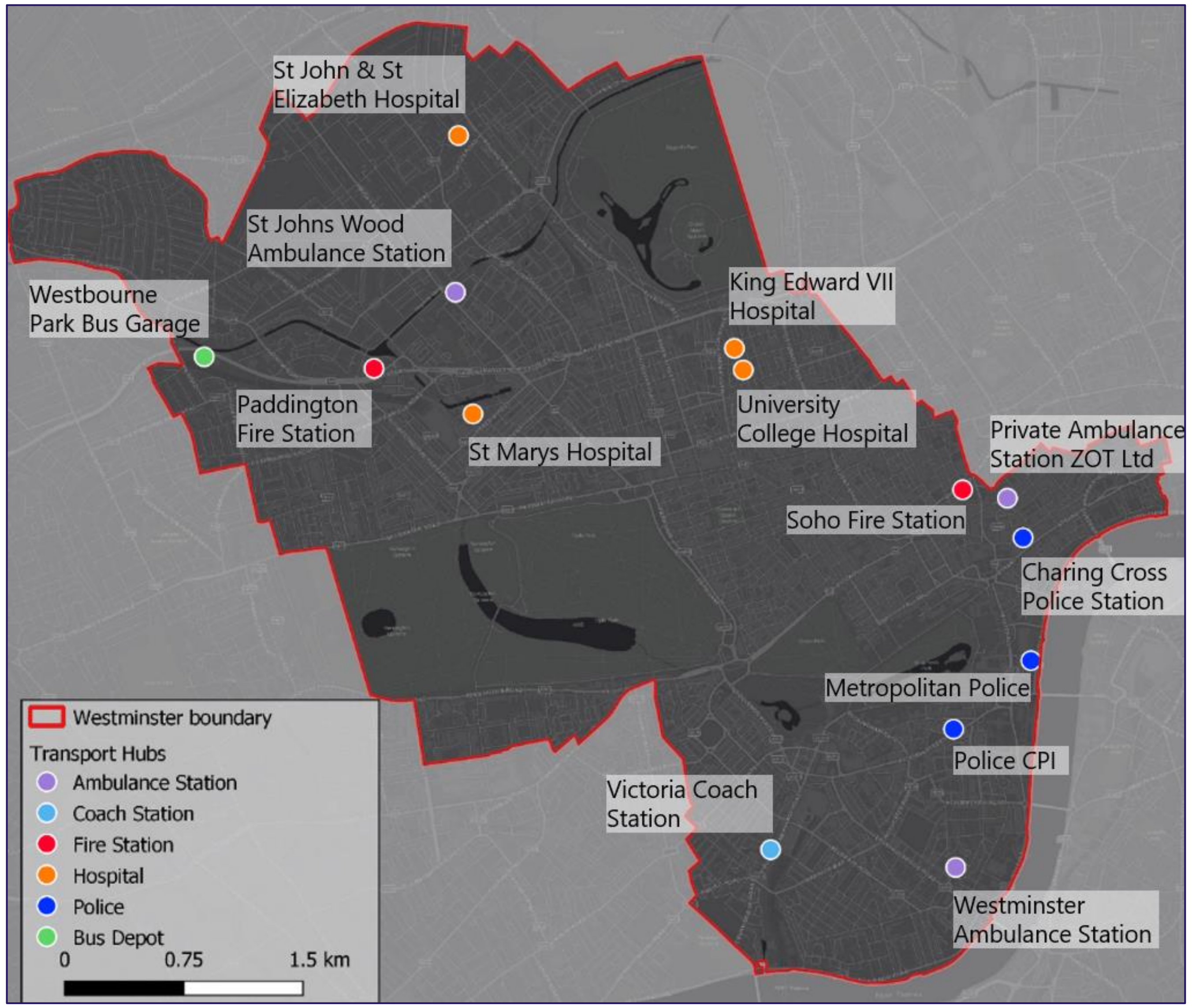
The current 2021 London Plan[51] provides guidance for all London Boroughs, which has been integrated into each borough's own planning regime. This EV charger guidance in Table 0—4 provides a summary of relevant requirements. For reference "active" charge points is where a charge socket is connected to the electrical supply system for vehicles to charge from, and "passive" charge points is where the cabling has been installed so that at a future date a socket may be installed.

Table 0—4 2021 London Plan EV charger guidance

Parking for	Percentage of bays with "active" charge point provision	Percentage of bays with "passive" charge point provision
Residential Development	20%	20%
Retail Development	10%	10%
Employment Uses	20%	10%

The car park EV charging analysis within this plan aligns so that 40% of bays have an "active" charge point proportion. Aligning to the 2021 London Plan Residential Development at "full-built out" so that the "passive" chargers become

49 https://opendata.camden.gov.uk/dataset/Westminster-Parking-Spaces/2579-98vt
50 https://www.gov.uk/government/organisations/valuation-office-agency/about/statistics
51 https://www.london.gov.uk/sites/default/files/the_london_plan_2021.pdf



"active". In addition to this, each charger is assumed to be of a 7 kW capacity, aligning to typical existing chargers in car parks of Westminster, e.g. Q-Park Chinatown. Electrical capacity statistics from the analysis of car parks is:

No. Spaces = 9,846 (from 68 car parks)

No. Chargers = 3,949

Capacity = 27,643 kW (27.7 MW)

The car park EV capacity requirements by LSOA is provided in Figure 0—11.

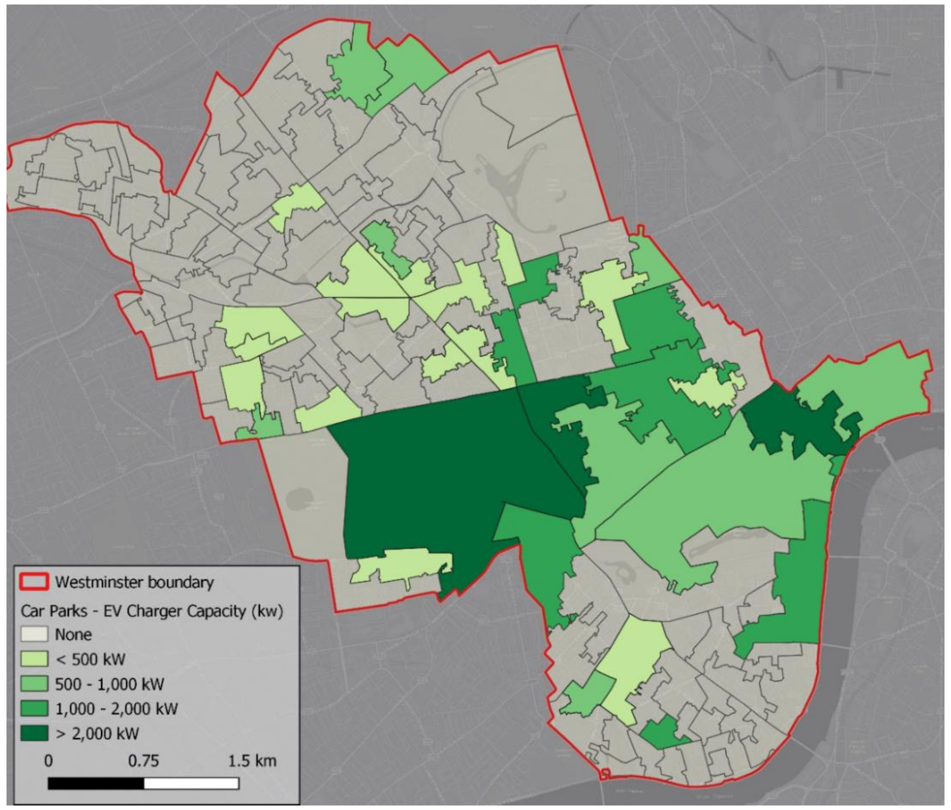


Figure 0—11 Westminster EV charger capacity per LSOA

Car parks were examined for PV canopy potential but the majority of car parks are below ground, meaning there is very limited potential for this technology.

Transport hubs

Transport hubs can be defined as key locations where passengers and cargo are exchanged between vehicles and/or between transport modes or whereby a fleet of vehicles are exchanged (e.g. Ambulance Station). These typically relate to larger road vehicles (i.e., coaches, buses and HGVs).

This does not include transport hubs relating to ports, railways or tube stations, due to the fact these modes of transport are better suited to the national or sub-national level, rather than local strategies to offset these emissions of vehicles travelling through the area.

Within Westminster 14 'transport hubs' were identified, split between six categories. While smaller EV vehicles will typically utilise smaller capacity slower chargers up to 7 kW, transport hubs will utilise larger capacity chargers due to either charging larger road vehicles or the need to charge vehicles quicker. This breakdown of chargers are defined as:

Fast chargers: 7 kW – 25 kW

Rapid and ultra-rapid DC chargers: 50 kW – 350 kW

The six 'transport hubs' identified and their number of each are below, along with their typical EV charger capacity requirement per charger.

- Ambulance Station (3) – 150 kW. St John's Wood, Westminster and a 'ZOT Ltd' Ambulance Stations.
- Bus Depot (1) - 350 kW. Westbourne Park Garage Depot.
- Coach Station (1) – 350 kW. Victoria Coach Station.
- Fire Station (2) - 350 kW. Paddington and Soho Fire Stations.
- Hospital (4) – 50 kW. St John and St Elizabeth, St Mary's, King Edward VII and University College Hospital
- Police Station (3) – 100 kW. Charing Cross, Metropolitan and Police CP1 Stations

The locations of these 'transport hubs' are presented in Figure 0—12.Figure 0—12 Transport hub locations within Westminster

These Transport Hubs will likely require grid reinforcement to the power infrastructure supplying these sites, due to the high average EV charger capacity requirement at each site. Infrastructure may also be required to integrate hydrogen charging at some of these locations.

Transport pathways and costs

The transport costs do not consider vehicle change but rather the charging infrastructure itself. This infrastructure cost does not include factors like electricity network upgrades, which is instead captured in the general infrastructure cost (as it is hard to meaningfully apportion what costs are incurred by transport and what from wider system electrification).

The cost directly associated with electric vehicle infrastructure is low compared to other elements of the LAEP, with the majority of chargers costing ~£1000, the charging infrastructure in the LAEP is costed at ~£15 million. However, it will incur additional costs for electricity network reinforcement.

Electricity network changes

The increase in electricity demand for the LAEP scenario compared to the present day is presented below in Figure 0—13.

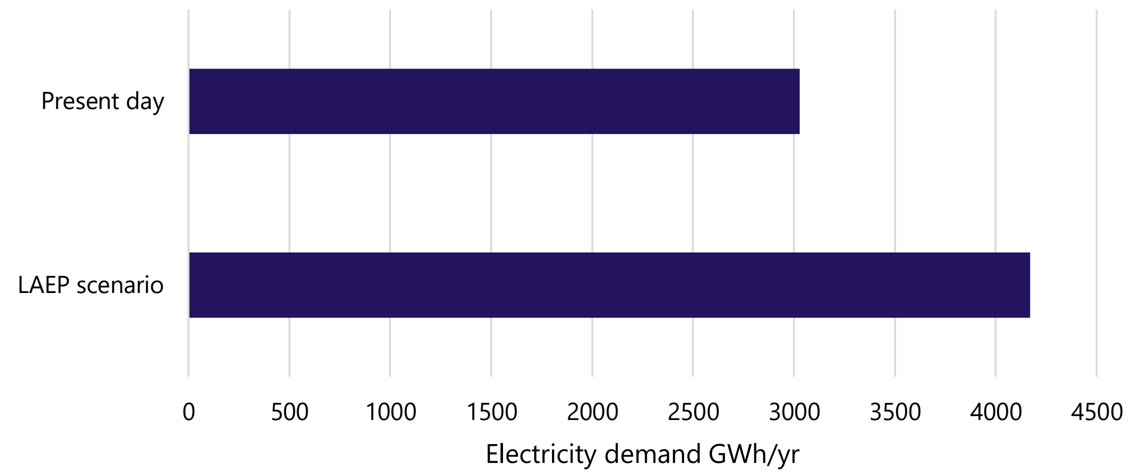


Figure 0—13 Annual electricity demand for the LAEP scenario in 2040 and the present day.

It should be noted that although the increase appears relatively small it is 1143 GWh/yr and the current average annual electricity demand in a London Borough is under 1000 GWh/yr.

This increase in electricity demand brings requirements for electricity network reinforcement. Much of the cost of these will be for infrastructure below the primary substation level explored in 0, however, the level of information below this level is very low.

By having centralised heating solutions (i.e. heat networks and communal systems) it helps reduce the cost of network upgrades. Also, a relatively high level of demand side management is included in the LAEP scenario, helping to reduce demand peaks. Even with these factors the forecast cost associated with network upgrades account for an additional £370 million. However, there could be potential to reduce costs associated with cable installation by combining civils work with elements of the LAEP – notably installation of heat network pipes.

Plan summary

LAEP pathway and Action Plan

A summary of required install rates for the LAEP is provided in Table 0—1.

Table 0—1 Summary of key technology install and actions to achieve the LAEP scenario.

Item	Current status/context	Requirement 2027	Requirement 2030	Requirement 2035	Requirement 2040
Domestic fabric improvement	60000 single glazed properties, 12600 properties with uninsulated cavity walls, up to 29000 with insulated roofs and 104000 uninsulated solid walls (not a priority).	Retrofit a total of 12000 properties.	Retrofit a total of 37300 properties.	Retrofit up to 79700 properties.	Retrofit up to 87600 properties.
		5400 of which are on land in WCC ownership.	*12400 of which are on land in WCC ownership.*	*14600 of which are on land in WCC ownership.*	*14600 of which are on land in WCC ownership.*
Non-domestic fabric improvement	23000 single glazed properties, 1800 properties with uninsulated cavity walls and 32000 uninsulated solid walls (not a priority).	Retrofit a total of 2600 properties.	Retrofit a total of 8900 properties.	Retrofit up to 19000 properties.	Retrofit up to 21000 properties.
		220 of which are on land in WCC ownership.	*450 of which are on land in WCC ownership.*	*500 of which are on land in WCC ownership.*	*500 of which are on land in WCC ownership.*
Property level heat pumps	Currently 1800 domestic heat pumps in Westminster, data is not reliable to provide a non-domestic figure	Total of 2300 additional property level heat pumps installed.	Total of 8000 additional property level heat pumps installed.	Total of 11600 additional property level heat pumps installed.	Total of 16600 additional property level heat pumps installed.
		350 of which are on land in WCC ownership.	*1100 of which are on land in WCC ownership.*	*1100 of which are on land in WCC ownership.*	*1100 of which are on land in WCC ownership.*
Communal and district heat networks[52]	Two large district heat networks, 43 WCC operated communal gas boilers. With other small communal networks total of 33200 properties connected.	Total of 3800 additional properties connected to communal systems or heat networks.	Total of 14000 additional properties connected to communal systems or heat networks.	Total of 71000 additional properties connected to communal systems or heat networks.	Total of 131000 additional properties connected to communal systems or heat networks.
		1400 of which are on land in WCC ownership.	*3900 of which are on land in WCC ownership.*	*8700 of which are on land in WCC ownership.*	*8700 of which are on land in WCC ownership.*
Electric vehicle infrastructure	2500 EV charge points currently installed.	Install an additional 1500 EV charge points.	Total of 2800 additional EV charge points.	Total of 6700 additional EV charge points.	Total of 10050 additional EV charge points.
Solar PV installation	2 MW of current PV capacity	21 MW of additional PV capacity.	44 MW of total additional PV capacity installed.	76 MW of total additional PV capacity installed.	89.5 MW of total additional PV capacity installed.
		5 MW of which is on land in WCC ownership.	*9 MW is on land in WCC ownership.*	*16 MW is on land in WCC ownership.*	*23 MW is on land in WCC ownership.*

An indication of the impact of these measures have on EPC grades is provided in Table 0—2.

Table 0—2 Summary of the changes in EPC from adopting LAEP technologies.

Item	Current status/context	2027	2030	2035	2040
Domestic EPC grades	52200 EPC A-C, 66200 EPC D, 22200 EPC E-G	55800 EPC A-C, 63700 EPC D, 21100 EPC E-G	78700 EPC A-C, 48000 EPC D, 13900 EPC E-G	114500 EPC A-C, 23400 EPC D, 2700 EPC E-G	120700 EPC A-C, 19100 EPC D, 800 EPC E-G
	Of which on WCC land 11300 EPC A-C, 10100 EPC D, 2200 EPC E-G	Of which on WCC land 14900 EPC A-C, 7200 EPC D, 1500 EPC E-G	Of which on WCC land 20900 EPC A-C, 2300 EPC D, 400 EPC E-G	Of which on WCC land 22700 EPC A-C, 800 EPC D, 100 EPC E-G	Of which on WCC land 22700 EPC A-C, 800 EPC D, 100 EPC E-G
Non-domestic EPC grades	14200 EPC A-C, 11100 EPC D, 12300 EPC E-G	14800 EPC A-C, 11000 EPC D, 11800 EPC E-G	19000 EPC A-C, 10300 EPC D, 8300 EPC E-G	25700 EPC A-C, 9300 EPC D, 2600 EPC E-G	28500 EPC A-C, 8800 EPC D, 300 EPC E-G
	Of which on WCC land 100 EPC A-C, 200 EPC D, 400 EPC E-G	Of which on WCC land 200 EPC A-C, 200 EPC D, 300 E-G	Of which on WCC land 350 EPC A-C, 250 EPC D, 150 E-G	Of which on WCC land 400 EPC A-C, 200 EPC D, 100 E-G	Of which on WCC land 550 EPC A-C, 100 EPC D, 50 E-G

The switch of heating system from heat pumps to gas boilers can have a negative impact on EPC performance in the domestic context, due to the relatively high cost of electricity compared to gas. For non-domestic EPCs there is a greater weighting towards carbon savings, so the impact of switching to low carbon technology generally has a more positive impact. The impact of different parts of the LAEP on emissions is better explored in Table 0—3.

Table 0—3 Approximate carbon savings (tCO_2) associated with the different low carbon technology deployment at each timestep.

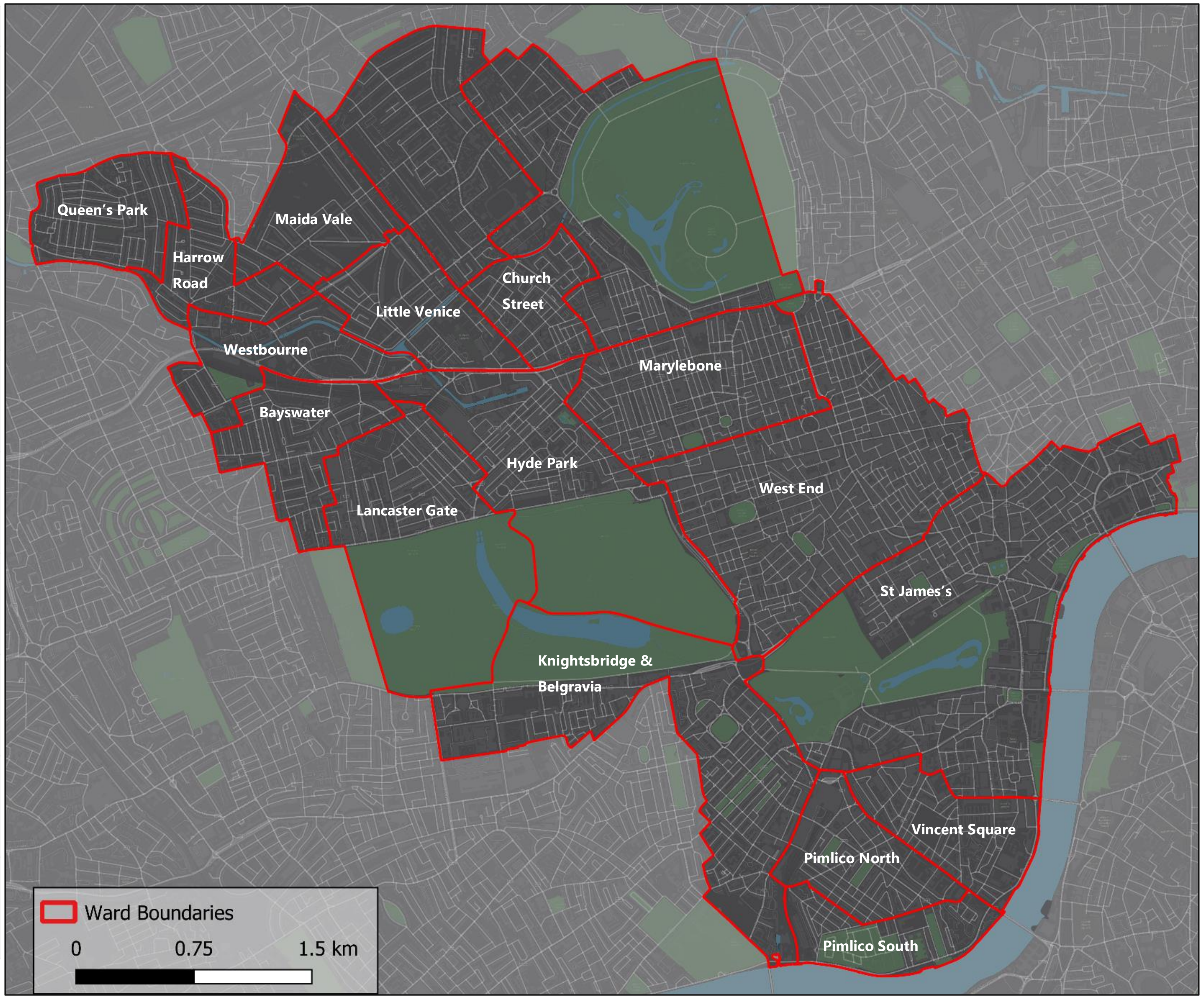
Item	2027	2030	2035	2040
Domestic fabric improvement	5471	17005	38239	39937
Non-domestic fabric improvement	8166	27954	59677	65959
Property level heat pumps	5021	37459	56549	81365
Communal and district heat networks	9505	36040	189327	350988
Electric vehicles and reduced mileage	41232	83105	168728	253092
Solar PV	1530	2182	1538	1449
Total	**70925**	**203745**	**514058**	**792790**

It should be noted that the total emissions based on total fuel consumption was 1,369,046 tCO_2 (this is lower than reported statistics which look at other factors) in 2021 – which is the most recent year for published data. The LAEP has residual emissions of 76,889 tCO_2, with the vast majority of the remaining 499,367 tCO_2 reduction being due to grid decarbonisation. The reduced impact of PV in later years (despite greater installed capacity), is illustrated in Table 0—3 with 2040 having the lowest saving. However, it is still an important measure for decarbonisation, as grid decarbonisation requires this widespread renewable deployment.

The following pages breaks down these requirements to a series of key actions for different key themes in subsections 0 to 0 – with key actions broken down further and stakeholder roles assigned. The costs and emissions pathways associated with these actions are provided in 0 and 0 with the next steps to aid delivery provided in 0.

Before this Figure 0—1 provides an overview of key technology interventions for different wards. Whilst nearly all wards will see all interventions, to a greater or lesser extent, in the LAEP this is more a focus of which interventions are most prevalent. The ward which sees the greatest mix of intervention types in Figure 0—1 is the West End. This highlights the complex nature of the decarbonisation pathway in the ward but also illustrates the broad variety of opportunities to decarbonise.

Ward	Key technology
Queen's Park	Property, Glazing, PV, Roof/loft
Harrow Road	Communal, PV, Property
Maida Vale	PV, Glazing, Communal
Westbourne	PV, Heat network
Little Venice	PV, Communal, Heat network, Glazing
Bayswater	Glazing, Communal
Lancaster Gate	EV charging, Glazing, Heat network
Hyde Park	EV charging, Communal, Heat network, Wall insulation, Glazing
Knightsbridge & Belgravia	Glazing, EV charging, PV, Roof/loft, Heat network



Ward	Key technology
Abbey Road	Glazing, Roof/loft, Property, Heat network
Regent's Park	EV charging, Wall insulation, Heat network, Property, Communal
Church Street	Heat network, EV charging, PV, Glazing
Marylebone	EV charging, Glazing, Wall insulation, Heat network
West End	Heat network, EV charging, Glazing, Property, Wall insulation, Communal, Roof/loft
St James's	EV charging, PV, Heat network, Glazing
Vincent Square	PV, Glazing, Wall insulation, Heat network
Pimlico North	Glazing, Heat network
Pimlico South	Glazing, PV, Heat network, EV charging, Wall insulation

Figure 0—1 Overview of LAEP for different Wards. Background imagery from ESRI and Ordnance Survey Crown Copyright data.

[52] There is a high degree of sensitivity in the relationship between communal and district heat networks. This includes some communal networks connecting to wider heat networks, uncertainty in data cataloguing for current systems, the varying scale in heat networks identified and the marginal cost difference between communal and heat networks in the model outputs.

Action Plan - heat

Legend: Central government | WCC | Private sector /individuals | DNO

2024 | 2026 | 2028 | 2030 | 2032 | 2034 | 2036 | 2038 | 2040

Heat networks

- HN1. Explore LAEP identified projects.
- HN2. DESNZ Heat Network zoning activity.
- HN3. **PDHU** decarbonisation and wider **SWAN** network, **Albert Hall** network and **Church Street**
- HN4. Delivery of second round of identified heat networks and heat network extensions, based on feasibility studies and zoning work.
- HN5. Continued heat network deliver and heat network extensions. This is likely to include more challenging areas like the West End.

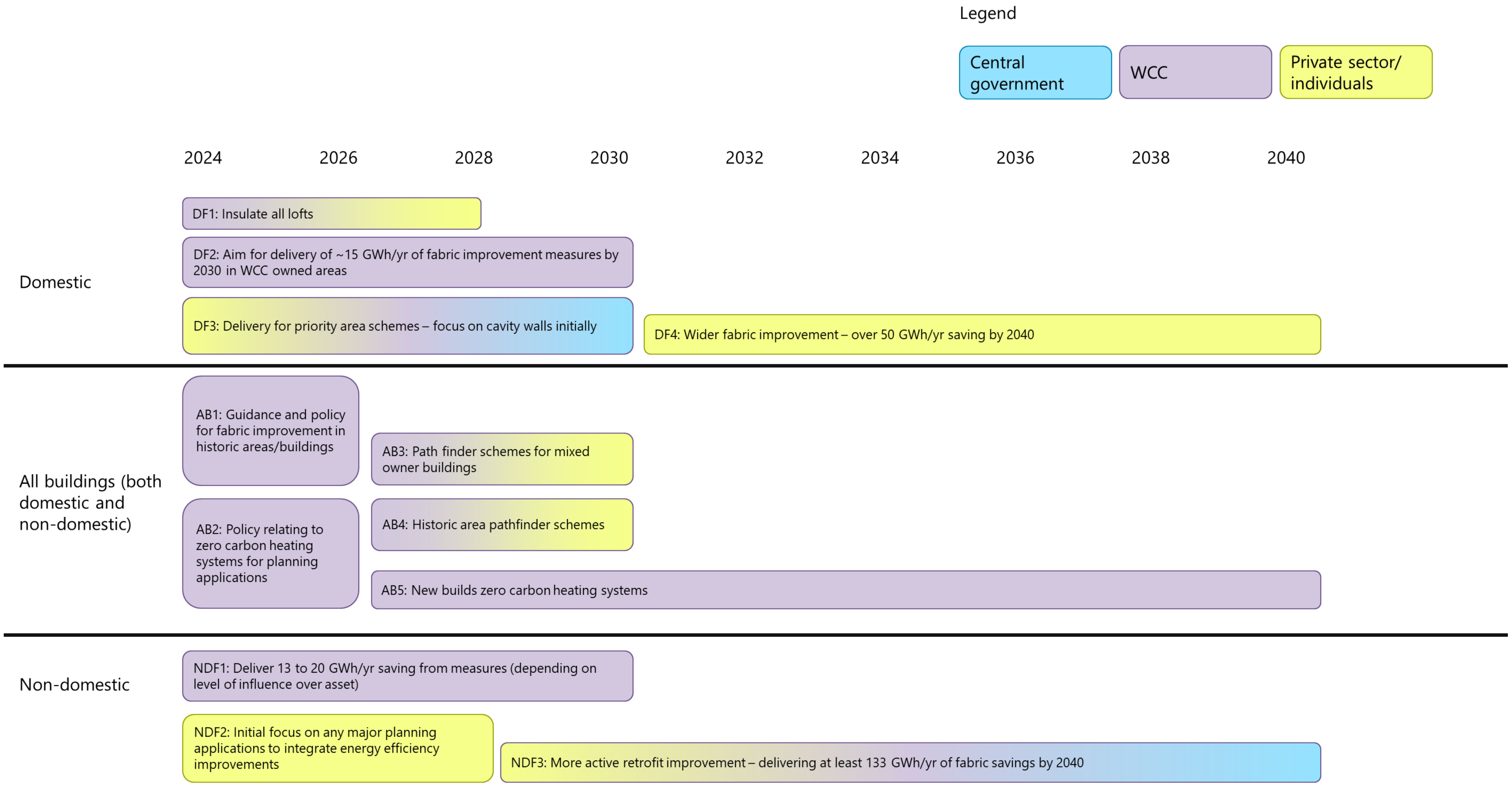
Communal systems

- CS1. Early focus on communal boiler **replacement to heat pump** be completed by **2030**. In some areas (e.g. Hallfield Estate)consider linking of multiple communal systems for a wider heat network.
- CS2. End of life **communal boiler replacement** with heat pump – targeting **2034** at latest for replacement
- CS3. Small scale **communal system path finders** – focusing on single owner solutions.
- CS4. Path finders for multiple owner communal switch, e.g. **flats** systems
- CS5. Scaling up communal system delivery – expanding from single building owners to more complex multiple owner models

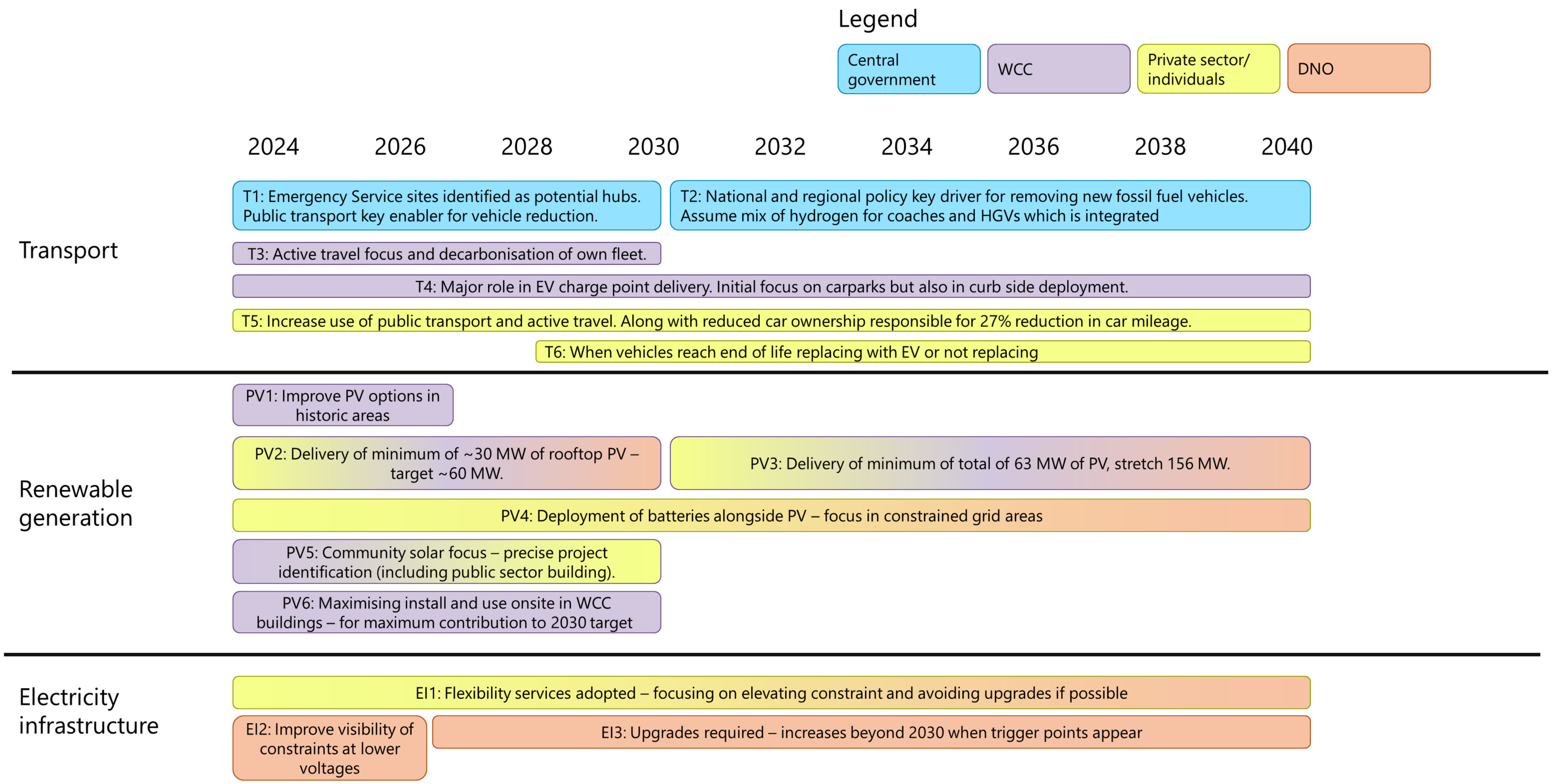
Property level heating systems

- PL1. Replacement of boilers (at end of life) with heat pumps in WCC properties (focusing initially on those not requiring high fabric improvement).
- PL2. Encourage replacement at end of boiler life with heat pump or similar technology.
- PL3. Require replacement of boilers at end of life with low carbon technology option or connection to a communal or district heat network.
- PL4. Consideration of improved diversity of electrified heating
- PL7. Improve system visibility and reduce cost for assessing electrification suitability assessments.
- PL5. Introduce policy for any new builds or major redevelopment to require low carbon heating system or connection to heat network or communal one.
- PL6. Encourage replacement of gas cookers with electric equivalent. Focus where suitable on WCC properties – whilst being conscious of fuel poverty.

Action plan – fabric improvements



Action plan - transport, renewable generation, electricity infrastructure



LAEP investment requirement and operational costs

Investment in the LAEP will bring additional benefits beyond cutting carbon. This includes improving air quality, which brings health benefits and associated savings for health services. At a consumer level the LAEP will help reduce fuel poverty, improve resilience to the impacts of climate change (e.g. heat waves) and improve comfort in the home (this is not only thermal but also factors like noise due to improved insulation). From a Westminster and wider London perspective the LAEP would being additional investment and an associated increase in jobs, with several thousand additional jobs being created to complete the LAEP. However, the LAEP Scenario for Westminster will require a large amount of investment; it should be noted that even the Baseline scenario will also carry a financial burden (including replacement of existing heating systems). The capital investment required is explored in Figure 0—2.

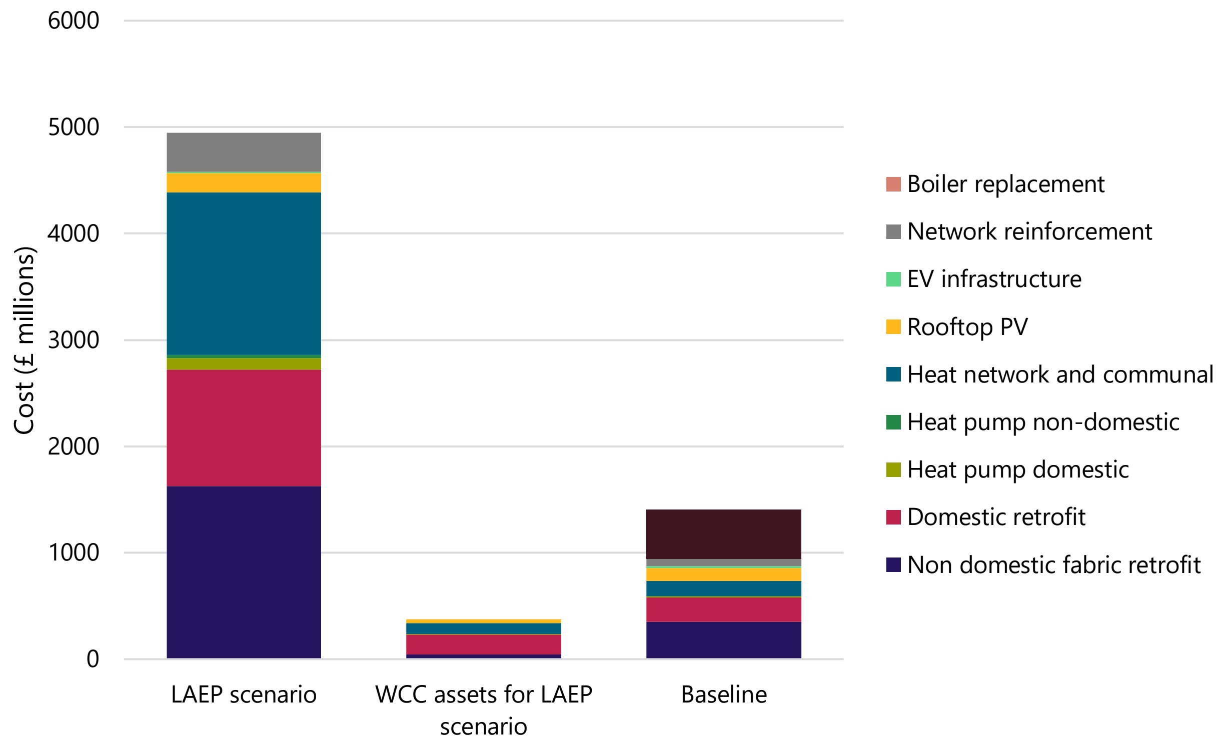


Figure 0—2 Capital investment required to 2040 for the final LAEP scenario, for the Westminster City Council assets for the LAEP scenario[53] and the Baseline.

There is a large amount of sensitivity with the capital investment requirement – particularly in relation to fabric retrofit of solid walls. Given the historic nature of Westminster's building stock this is very widely spread and would require a building-by-building assessment to understand the exact requirement for wall insulation. This could potentially result in ~£750 million of fabric retrofit reduction measures combined between the domestic and non-domestic properties. There is also sensitivity regarding how much of the glazing cost incurred for the LAEP is additional. The fabric retrofit costs in the LAEP scenario fall between those of the high and low ambition options described in Section 0. There are a reduced number of solid wall improvements compared to the high ambition scenario but the glazing level is generally in line with the high ambition scenario[54].

Residents in Westminster, who are owner occupiers, will need to contribute part of this overall investment but the majority of the required investment would come from other sources. The spend on heating systems is an example where in a large number of cases much of the investment is unlikely to be met by residents, due to high prevalence of heat networks and communal systems – where many of the upfront investment would likely be met by a central provider.

It should be noted that the heat networks and communal systems do rely predominately on heat pump technology in some form. However, in the figures captured in this section heat pump costs only refer to the domestic and non-domestic property level solutions, which is why they make up a relatively small share of the overall investment.

The investment in rooftop PV is relatively high due to recent increases in panel price (although these are assumed to reduce somewhat overtime) and the inclusion of batteries with some systems to optimise the value of the generation.

The total investment will spread across the period of the LAEP, an indication of this is provided in Figure 0—3.

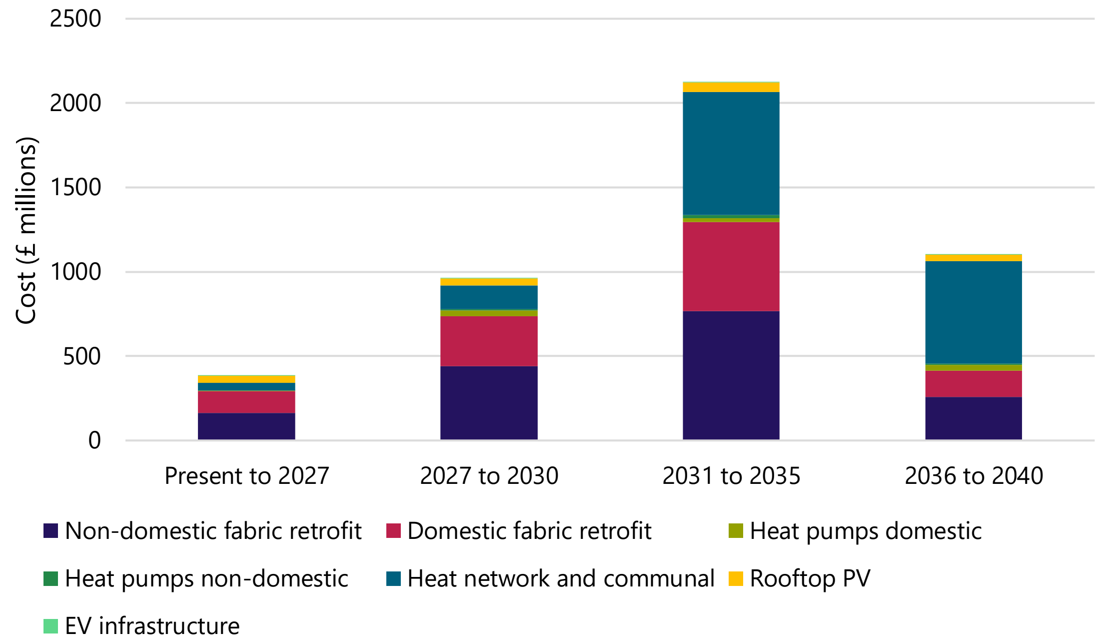


Figure 0—3 Investment for different key time periods in the LAEP.

The fabric retrofit focuses on lower cost quicker items first, as these are uniform across scenarios. For heat networks upfront spend is required before project delivery. The long times means there is a slight front loading of costs prior to connection for this technology. Electrical infrastructure upgrades are not included at this resolution due to uncertainty about precise trigger points for reinforcement.

Whilst the capital investment required is high it does result in savings in operational costs for the energy system. An overview of the different operational costs, based on fuel and carbon, for the LAEP Scenario and Baseline are provided in Figure 0—4. These values are based on the Green Book data tables published by DESNZ[55], using the medium retail scenarios for energy and carbon price.

[53] In this instance assets are any properties on WCC owned land, this is likely to overestimate the total WCC cost. The grid reinforcement is not included in the WCC cost as this is cumulative across the scenario for all assets. Heat networks are proportionally attributed to WCC based on installations but this not wholly reflective of how costs would be split. Electric Vehicle infrastructure is kept at the whole area level as WCC's internal transport team already have a detailed strategy for charger roll out.

[54] This is based on engagement with heat pump installers in historic properties.

[55] DESNZ, 2023: Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal. https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

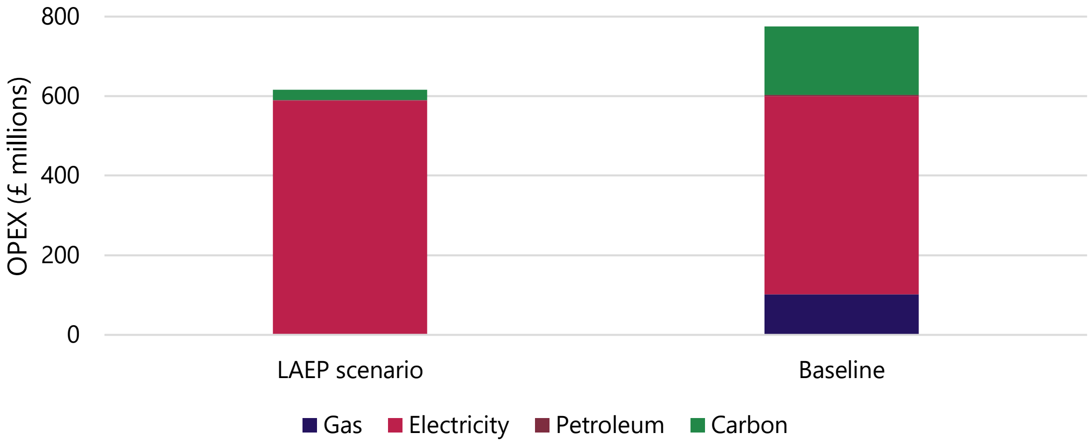


Figure 0—4 Fuel and carbon costs[56] for the LAEP scenario in 2040 compared to the Baseline.

There are some marginal savings (£13 million) identified per year based on fuel costs in the LAEP scenario. This is relatively low as even though the LAEP Scenario is far more efficient the price of commercial electricity is ~3.4 times that of gas[57]. For contrast in the high fuel cost scenario in the Green Book the price of commercial electricity is only double the price of gas in 2040 – making the fuel-based saving more substantial (~£85 million). The variability in the relative cost of electricity compared to gas is explored further in Figure 0—5.

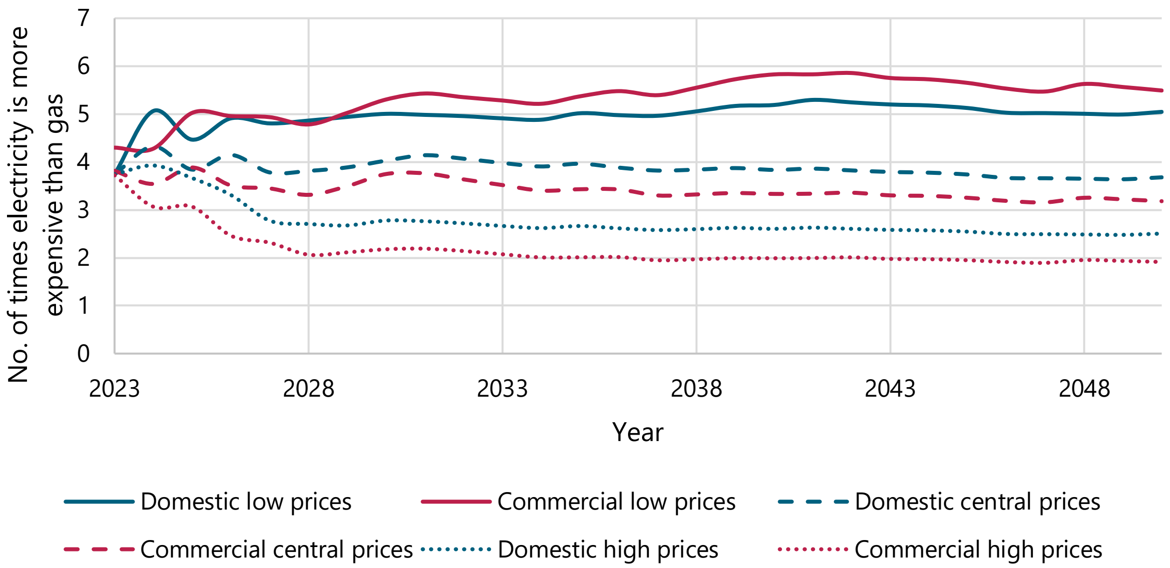


Figure 0—5 Comparison of the relative cost of electricity compared to gas in the UK Government Green Book for domestic and commercial consumers.

In later years the Green Book does show a greater separation between electricity and gas prices (particularly for commercial consumers), however, gas maintains a lower price than electricity across all scenarios – before carbon pricing is taken into account.

Even with the high fuel cost it is carbon pricing (taken from the DESNZ Green Book) which is the most important factor between scenario costings, the LAEP Scenario has a modelled spend of £26 million on carbon in 2040 compared to £172 million for the Baseline. The majority of the remaining carbon in the LAEP scenario is from a not fully decarbonised grid and would need offsetting to reach net zero. Carbon price increases overtime whilst the electricity grid carbon factor decreases, as well as technology deployment these factors contribute to the greatest being seen towards the end of the LAEP modelling period – see Figure 0—6.

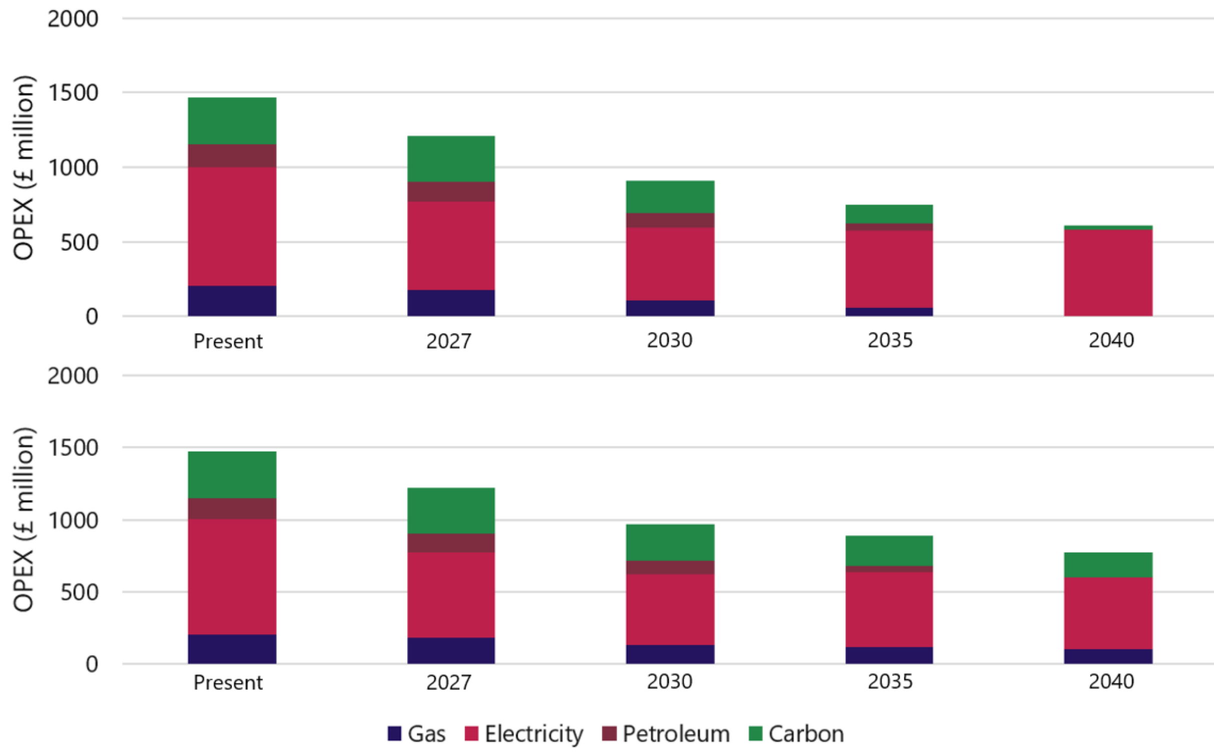


Figure 0—6 Summary of OPEX for different years throughout the LAEP time frame. The top graph represents the LAEP Scenario and the bottom the baseline.

The trend of performance of the LAEP Scenario performing better than the Baseline improves with time. This is illustrated in Figure 0—7 which examines the relative saving between the LAEP scenario and Baseline at different timesteps to 2040.

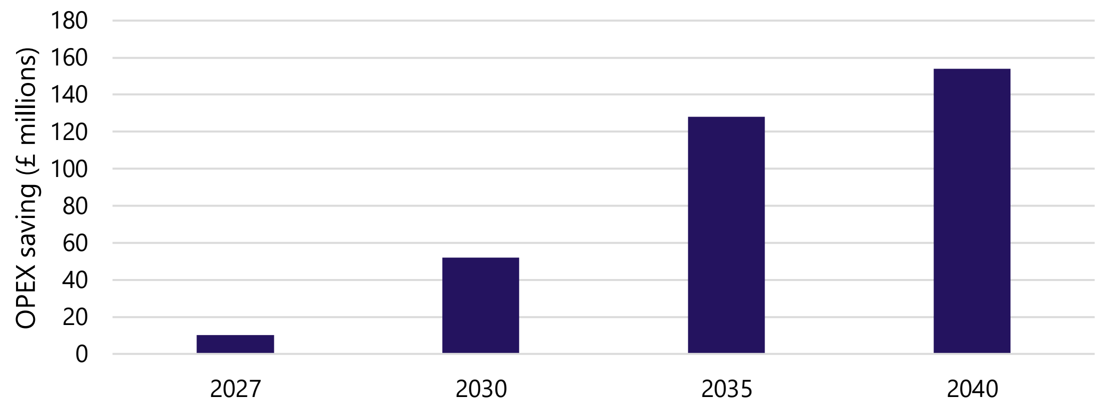


Figure 0—7 OPEX saving in LAEP scenario compared to the Baseline.

By 2050 the commercial price of electricity is ~3.3 times the price of gas and the carbon price increases by ~16%. This means the current ~£154 million difference in OPEX in 2040[58] increases to ~£181 million in 2050.

[56] All costs are based on Green Book central scenarios for retail energy prices and carbon costs.
[57] Commercial prices are used as they are more suitable for communal systems and heat networks that will provide the majority of heating system capacity.
[58] Under a high cost scenario based on Green Book values this difference increases to £295 million.

The relatively long payback indicated by these OPEX values compared to CAPEX is due mainly due to the historic building buildings in Westminster. Fabric improvement of these is more costly than for standard local authorities[59]. Additionally, the benefit of the high heat density of Westminster, which generally makes a low carbon energy transition more cost effective, is somewhat mitigated by the high costs associated with installing infrastructure such as district heating pipe in the area.

LAEP emissions

The LAEP focuses on emissions related to direct energy used within the Westminster local authority boundary. This means there are some notable exclusions such as emissions related to food and construction in addition to items that are but considered at a regional or national level – for example train travel. A summary of the emissions reduction pathway for the LAEP Scenario compared to the Baseline is provided in Figure 0—8.

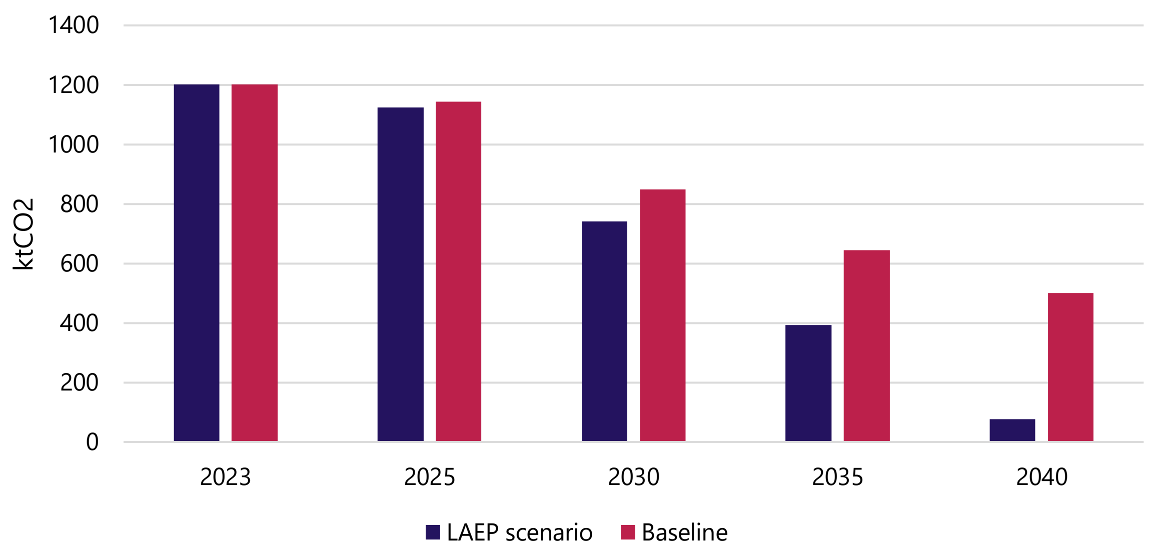


Figure 0—8 Carbon emissions based on primary energy consumption to 2040 for the LAEP scenario and Baseline.

The pathways appear relatively similar for the LAEP Scenario and Baseline in the early years, this is primarily due to the similar pathways for transport and the decarbonisation of the electricity grid. After 2030 is when the pathways start to substantially diverge, due to the electrification of heating in the LAEP Scenario.

This emphasises the importance of the time up until 2030 for enabling the shift to low carbon systems. This includes having suitable building fabric and various enabling factors. Heat networks and communal systems are a key example of the need for enabling factors. The project scale and infrastructure requirements of the former create a long lead in time, whilst the communal schemes will require significant stakeholder engagement – particularly in cases with a high level of private ownership.

Next steps

The LAEP identifiers a pathway for Westminster to achieve a net zero energy system, however, there are many options and actions that can be taken for this to be achieved. This section examines priority projects to take forward early and creating the environment for LAEP adoption.

Priority projects

These are precisely located projects which have been identified as low regrets and/or achievable in the near term. Low regrets projects are often those where the same low carbon interventions are identified across multiple test scenarios. This list is a short list, for a more extensive list see sections 5 to 7. The priority projects consider greatest payback, potential for WCC to influence and the scalability they offer. Priority projects identified directly through the LAEP are detailed in Figure 0—9.

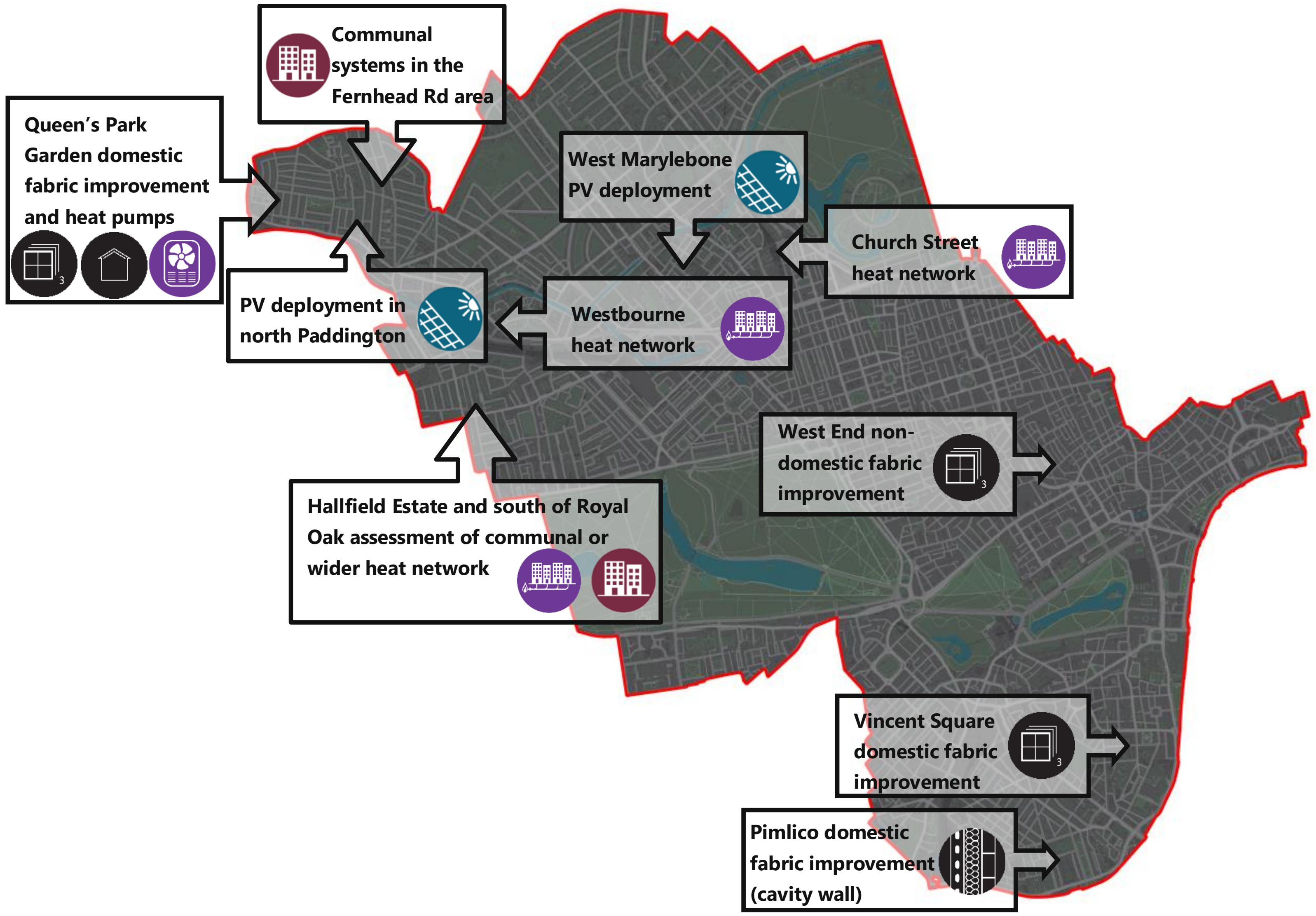


Figure 0—9 Priority projects. Background imagery from ESRI and Ordnance Survey Crown Copyright data.

[59] This is based on insights from UCL, 2020: Analysis Work to Refine Fabric Energy Efficiency Assumptions for use in Developing the Sixth Carbon Budget; and Element Energy, 2020: Trajectories for Residential Heat Decarbonisation Summary.

Priority projects were considered in the context of nine different key parameters:

1. Fuel poverty – areas with a high level of fuel poverty are considered for early interventions to try and bring down costs.
2. Cost – a relatively low initial investment requirement is helpful for deploying a large number of projects. It should be noted that this does not exclude high upfront investment projects like heat networks, it more a limit on the number of high initial investment projects that can be taken to the priority project shortlist.
3. Alignment across scenarios – if a technology is flagged in an area across all scenarios it is considered a priority, as it indicates that is compatible with all decarbonisation pathways.
4. Scalability – how widely the solution can be used across Westminster. This means that learnings from the project can be applied across Westminster as the LAEP progresses. This is important as there are certain measures which will require large scale roll out for the LAEP.
5. Data confidence – the LAEP is based on modelled data and whilst there has been extensive validation there is less certainty in the data behind identification of some projects than others. A high confidence in priority projects is important to enable deployment and move the LAEP forward.
6. Speed of deployment – it is important that some projects can be deployed and progressed quickly. Some larger projects will require a longer lead time, a mix of different project speeds is considered favourable.
7. WCC influence – a high level of WCC ownership will help early deployment and project progression.
8. Deployment complexity – some projects will have greater complexity. This covers a variety of factors including technical challenges as well as non-technical such as the involvement of a large number of stakeholders. This creates potential risks in terms of project delivery.
9. Additionality- this final scoring criteria for the shortlist is based on whether the project is identified sue to the LAEP. If not it is not taken for further shortlist analysis due to the lack of added value.

The scoring of a longlist of projects identified (including the final priority ones in Figure 0—9) is provided in Appendix B.

Alongside these factors once a longlist assessment was carried out several additional factors were considered:

- Combining multiple projects
- Ensuring a good geographic spread
- Having a good representation of different project interventions – this is important as it helps prioritise projects which may be more challenging but are crucial to the LAEP. For example, PV deployment is a large element but it is relatively simple compared to fabric improvement.

Alongside these newly identified priority projects ongoing work in Westminster is integral to the LAEP and these projects should also be continued as a priority. These schemes were dominated by heat decarbonisation, with five key projects and themes being:

- Replacement of WCC communal boilers and identifying opportunities to switch to low carbon heat pumps.
- The SWAN heat network represents the most significant near to mid-term single decarbonisation project in Westminster.
- The potential for heat network deployment around the redevelopment of St Mary's Hospital (this is also discussed below in the context of WCC site allocations).
- The heat network in the South Kensington area, which would extend into the neighbouring borough Kensington and Chelsea, is another well-developed scheme that is assumed to progress in the LAEP.
- Not all the key projects currently being considered are contingent on WCC. What was clear from stakeholder engagement is the large landowners in Westminster are progressing decarbonisation strategies. Perhaps the largest of these is the Crown Estate's ambitions around small heat networks between their own buildings in Regent Street.

Additionally, four specific site allocations provided by WCC were explored in the context of the wider LAEP, to ensure their use aligns to the plan. The locations of these is provided in Figure 0—10.

Figure 0—10 Key site allocations highlighted by WCC. Background imagery from ESRI and Ordnance Survey Crown Copyright data.

Westbourne Park Bus Garage is currently one of the key transport hubs – which would necessitate bus charging infrastructure if it was to keep a similar use. If this use were to change it is adjacent to the proposed Westbourne heat network location. Any development should consider connecting to this and potentially enabling the construction, providing space for plant room. A similar strategy should be pursued for the land at and adjacent to Royal Oak Underground Station.

St Mary's Hospital is one of the largest heat demands in Westminster. The site would thus be key for any heat networks in the area. This is identified in the DESNZ Advanced Zoning Programme for heat networks. The ambulances would require substantial deployment of high-capacity chargers, which is important to consider as it will impact the demands on the grid in the local area.

The Grosvenor Sidings could be of high value to the SWAN heat network – allowing a connection route over the main line into Victoria Station. Being next to PDHU and in the SWAN area connection to a heat network or being heat network connection ready is key to any development in the area.

Appendix A Stakeholder final workshop – summary notes

Final Workshop held on (18.10.2023)

The final workshop was held in Westminster city hall to present outputs of the LAEP. The attendance were grouped based on following themes:

- Heat,
- Electricity generation and storage,
- Transport and
- Insulation and retrofit

Following the presentation we invited everyone to for an around the table workshop asking following questions:

1. What do you think of the preferred pathway and the areas that have been prioritised under your theme?
2. What do you think of the priority projects?
3. Are there anything missing (e.g. major developments, other projects, opportunities to collaborate cross-boundary?)
4. What order should we tackle the priority projects in?
5. Is there anything you/your organisation can do to help bring some of the proposed projects forward?

Below are a summary of common themes with comments gathered during the workshop from various stakeholders.

Heat

Suggestions / Challenges:

- Engage with the main developers at early stages to connect to HNs and encouraging compatibility of the secondary side and compatibility of the primary side.
- Aligning public realm improvement works with HN expansion plans (e.g. Crown Estate planned public realm improvements work or the Oxford Street regeneration).
- Identifying the gas boilers coming to their end of life as first roll out.
- We need a more joined up thinking around embodied carbon, improved efficiencies, space gain/loss for energy centres.
- Cold Pluming from heat pumps could cause micro-climate issue. A wider study should be done to understand the wide scale implementation of Heat pumps in densely populated areas.

Opportunities:

- The Crown Estate is developing a number of ambient loop schemes. Each proposal roughly connects around 10 buildings providing heat sharing opportunities. This intersects the identified ambient loop network on Oxford Street. Potential for the Crown Estate to be the lead for developing a network for the West End.
- Opportunity to collaborate cross-boundary with Brent South Kilburn Heat Network.
- Oxford Street – engage with the Oxford Street Programme team on the feasibility of proposed ambient loop network- timeframe-wise they will be delivering all public realm works by 2026.
- Large Euston Development (HS2 + Euston Tower) – could this interface with WCC?
- Ground Source Heat Pump Eton Square.
- Grosvenor Square Plan.
- Provide a case study to the homeowners with the commercial case to demonstrate the domestic HP installation.

Electricity Generation & Storage

Suggestions / Challenges:

- Victoria/ Millbank needs to be priority and happen first.
- Analysis of where homeowners live in their home in Westminster needed. Need to target them first, landlords not the freeholder.
- Stamp duty discount if you are going to implement/upgrade retrofit measures.
- Use schools as route onto communities
- Clear education and marketing campaign – hubs (citizens' climate advice hubs/ libraries), letter drops.
- Keen for more Solar Together type approaches.
- Focus on domestic makes sense as commercial buildings offices lack roof space due to other constraints – chillers/ biodiversity/ open spaces for wellbeing.
- Better understanding of heritage restrictions to encourage implementation in the right places.

Opportunities:

- Solar on flat roofs without planning permission.
- Use of the large parks in Westminster for generation opportunities.
- Ways for residents to financially support community energy projects (not on their own properties) – car parks, hospitals, etc. e.g. crowd source funding
- Put PVs in where we have EV charging

Transport & EV Charging Points

Suggestions/challenges

- Prioritising the removal of vehicles vs switching to EVs by encouraging active travel
- Cycle Infrastructure improvements
- Save time travelling back and forth by doing fuses in batches rather than ad-hoc (need advanced knowledge) (UK Power Network).
- Will charge points be 'smart'? – Look at V20 so Council owned chargers can earn revenue.

Opportunities

- Pedestrianise Soho - WCC have looked at zero emissions zone but pushes traffic elsewhere. Alternative transport strategies to reduce HGVs in this area.
- WCC have freight delivery strategy
- Grosvenor Hill – possible area to prioritise EV infrastructure 200 parking spaces. Could be used also for micro mobility, not just residents. Used by local car dealers with Public Residential above it. (Victoria Herring, Grosvenor)
- First Mile – 1 cargo bike takes 3 HGV's waste off the road, lots of data available. Grosvenor Pilot.
- Holborn and Crown Estate are doing consolidated waste to reduce journeys.
- Get BIDS involved to help find Pilots.
- Local air quality – used to communicate impact.

Insulation and retrofit

Suggestions / Challenges:

- Change the planning regs (let there be no rules and a discount) for at least 3 years. Crown Estate PV being blocked by Planning. Camden did a deal with a supplier – waved planning permission & gave discount if enough people signed up.
- Westminster should lead this for the whole UK starting with Victoria Millbank estate.
- When are people going to pay – now or later. Everyone is hanging on for future grants.
- Lack of motivation from wealthy residents – how to incentivise the 'able to pay'
- Retrofit programme experience of Grade II listed / Heritage areas. It's perceived to be more of an issue than it is. Listed buildings consent orders / blankets policy for solar on Grade II in Kensington & Chelsea.
- Challenge in West End – including mixed use buildings.
- Consent – from building owners / tenants? Has to be resident-led or won't get through front door.

Opportunities:

- New developments (at pre app/planning stage) - needs to be highest possible standard.
- Need green skills - in conservation and heritage areas and to permit range of acceptable measures
- Climate hubs needed in the community to help people learn. Case studies for sharing and upskilling – for those without knowledge
- Incentivise / obligate people doing retrofit
- What do we do in the meantime while people are in the queue for retrofit works? Cheap/low cost investments e.g. draughtproofing, radiator reflectors etc. Could be done at scale quickly.

Priority projects

- Need to look at all potential projects – properly assess potential impacts (benefits, potential learning) then engage locally to flip the conversation and get grassroots feedback to shape projects.

- Non-Domestic
  - Big opportunity in West End
  - Need buy in from large landowners (currently not working in collaboration)
  - Needs to be a whole building approach - make most of all opportunities.
  - Hallfield / Vincent Square listed – could be considered early on.
- Cavity Wall Insulation
  - Consider Pimlico South Area and Churchill Gardens
  - Build heritage elements into planning in Pimlico North
  - Church St already done
  - Mix of focus - WCC and non-WCC owned assets

Appendix B Priority project longlist and scoring

This provides a summary of the priority projects identified in the LAEP and how they score in a RAG analysis based on different criteria. For more detail of these criteria please see 0. The shortlisted priority projects are the first ten in the table.

Project name/description	Fuel poverty	Cost	Alignment across scenarios	Scalability	Data confidence	Speed of deployment	WCC influence	Deployment complexity	Additionality
Queen's Park Garden domestic fabric improvement and heat pumps – flagged for multiple different domestic property level interventions, with factors like fuel poverty and WCC ownership causing its prioritisation. There are benefits to a holistic approach, particularly given the common typologies of buildings – which is why multiple interventions (heat pumps, roof insulation and glazing improvement are grouped).	Green	Amber	Amber	Green	Green	Amber	Green	Green	Amber
Communal systems in the Fernhead Road area - Fernhead Road runs down the centre of has a very high portion of small communal systems identified. This means there a high volume of similar projects, delivery of which can be scaled. The properties are extensively small-scale flats mixed with terrace properties, so whilst the model highlights communal systems it will also be suitable for relatively large scale deployment of property level heating systems. Location outside of a conservation area means deployment of visible heat pumps will be less challenging from a planning perspective. This is important as given the scale of the flats a ground mound system may be more appropriate than a rooftop system.	Amber	Amber	Green	Green	Amber	Green	Amber	Amber	Green
West Marylebone PV deployment – the buildings are suited to PV deployment, both domestic and non-domestic. The area also includes some of the larger WCC assets identified as having PV potential (including schools). The relatively low cost and easy deployment help make it a priority project. The area is close to one of the more constrained substations in Westminster, meaning integration of battery technology would be beneficial in this situation alongside PV – as there is a possibility of future flexibility opportunities in the near term.	Amber	Green	Green	Green	Green	Green	Green	Green	Amber
PV deployment in north Paddington – the area has a large amount of WCC assets and relatively few listed buildings helping to make it a focus for PV deployment. Large scale deployment of PV and battery storage could be coordinated by WCC. Other local authorities are examining grouped flexibility offerings through similar projects.	Amber	Green	Green	Green	Green	Green	Green	Green	Amber
Westbourne heat network - the Westbourne area has a large number of flats (which include some existing communally heated properties), Westminster Academy, a clinic and high proportion of Westminster owned assets. It is also next to Regent's Canal, which could be considered for a water source heat pump and Westbourne Green Open Space that could potential host boreholes for ground source heat pumps. These factors combine to make the area one of the priority heat network areas identified in Westminster.	Green	Red	Green	Green	Amber	Red	Green	Amber	Green
Church Street is suited to a **heat network** - it has a high level of WCC ownership, this includes existing communal systems that could act as valuable anchor loads. The area is in close proximity to the large grid substation at St Johns Wood (a potential source of waste heat) and has a number of planned new developments in the area with large anticipated demands. A previous feasibility study has confirmed its viability – it is understood WCC are already looking to update this with a heat pump solution.	Green	Red	Green	Green	Green	Red	Green	Amber	Amber
Hallfield Estate and south of Royal Oak assessment of communal or wider heat network - the Hallfield Estate area includes a large primary school and the Queensway development, which comprises new homes, retails and offices. The Hallfield Estate includes greenspace which could host boreholes for ground source heat pumps and potential some air source heat pump capacity. It should be noted that this is a relatively time critical project as the new developments are progressing and WCC has a communal boiler replacement programme. Aligning the strategy will be key to minimise costs associated with a heat network in the area,	Amber	Red	Amber	Green	Amber	Amber	Green	Amber	Green

Project name/description	Fuel poverty	Cost	Alignment across scenarios	Scalability	Data confidence	Speed of deployment	WCC influence	Deployment complexity	Additionality
this time critical element is a key reason it is prioritised alongside the standard considerations. The south of Royal Oak station is identified for communal systems it is an area with relatively few large demands surrounded by areas more suitable to heat networks. It is dominated by terraced domestic properties that are identified as buildings with multiple properties. It includes a high proportion of WCC ownership, with a particular focus around Porchester Square. It includes 24 existing communal boilers, which present an initial focus for decarbonisation. The potential for either communal or heat network solutions is somewhat time critical, which increases the prioritisation. It could potentially link with the St Mary's Hospital heat network opportunity discussed below.									
West End non-domestic fabric improvement – the whole of the historic Westend area has a large number of historic and relatively inefficient properties that are somewhat challenging to decarbonise. Some level of fabric improvement is shown across all scenarios. Starting to deliver schemes in the area will be key to understanding what at a project level is required to achieve the improvement needed for low carbon heating technologies to be effective as well as meeting policy targets like MEES. WCC has relatively little influence in the area but this can in part be mitigated by key stakeholders such as the Crown Estate and Grosvenor Estates, who are taking an active role in understanding what measures are most suitable.									
Vincent Square domestic fabric improvement - WCC-owned flats dominate the area (~1000), where around 70% requiring a glazing upgrade. It is thus an early focus for glazing improvement and as it includes buildings in conservation areas it will be a good case study for roll out of improved glazing in this challenging but usual geography in Westminster.									
Pimlico domestic fabric improvement (cavity wall) – the area is flagged has having a high number of uninsulated cavity walls. This is often one of the most cost effective insulation measures and is thus considered a priority. The area consists of around 900 WCC owned properties with majority 70% cavity wall insulation (~70%). Similarly, the Pimlico South is a large area with high density of flats cavity wall insulation. About 50% of the properties are owned by WCC.									
Marylebone domestic solid wall insulation – the area is identified as suitable for solid wall insulation, with 800 properties falling within the EPC E-G range. Majority of the properties are under the Portman Estate ownership; this presents an initial opportunity to purse a retrofit program in this area.									
Lancaster Gate domestic fabric improvement – the area has over 1400 properties falling under the E-G EPC band, the majority of the properties are requiring more than one retrofit measure and could notably benefit from solid wall insulation.									
North Regent's Park domestic fabric improvement – the area encompasses approximately 2000 properties, mainly low-rise flats. The majority of these properties are requiring solid wall insulation, with over 500 properties being owned by WCC, there is an opportunity to initiate a retrofit program in the area.									
Scott Ellis Garden fabric improvement - comprises over 400 WCC owned low-rise flats, given the relatively high fuel poverty in this area, the properties notably benefit from undergoing solid wall insulation leading to demand reduction and comfort improvement.									
Westbourne area cavity wall insulation - primarily low-rise flats with high WCC ownership (~80%). About 40% of properties need cavity wall insulation. Given the relatively high fuel poverty level in this area, the properties could highly benefit from demand reduction and comfort improvement through fabric retrofit. This could be considered alongside the heat network – a geographic spread of the priority project was the main reason it was not one of the nine priority projects.									

Project name/description	Fuel poverty	Cost	Alignment across scenarios	Scalability	Data confidence	Speed of deployment	WCC influence	Deployment complexity	Additionality
Westbourne Park Road area cavity wall insulation - dominated by low-rise flats and high WCC ownership (~70%). Almost half the properties require cavity wall insulation. High share of WCC ownership could accelerate the fabric retrofit program in the area. This could be considered alongside the heat network – a geographic spread of the priority project was the main reason it was not one of the nine priority projects.	Green	Green	Green	Amber	Amber	Green	Green	Amber	Green
Church Street cavity wall insulation – the area is primarily low-rise flat with rather high WCC ownership (~60%). About 40% of council-owned properties need cavity wall insulation. Given the relatively high fuel poverty level in this area, the properties could benefit from demand reduction through fabric improvement. The Pimlico cavity wall insulation was selected as a priority project to allow a greater spread of typologies and geographies but in many ways this is similar and could be considered alongside it.	Amber	Green	Green	Amber	Amber	Green	Green	Green	Amber
Queen's Park Garden roof insulation - has a large share of terrace houses and WCC ownership where 70% of properties requiring loft top up. In addition to the noticeable comfort improvement, a loft upgrade could enhance the heat pump performance if a heat pump rollout happens in the area. The area is also located in North Paddington Program.	Green	Green	Green	Amber	Red	Green	Green	Green	Green
Abbey Road roof insulation - the area is dominated by private detached/semi-detached properties, with about 75% of them requiring loft top up. This is a low-cost low-disruption intervention that could also improve the heat pump performance if HP roll out happens in the area.	Amber	Green	Green	Amber	Red	Green	Red	Green	Green
Chester Square roof insulation - the area has large number of privately-owned terrace houses and low-rise flats where about 65% of properties needing a loft top. The area has also been identified as suitable for heat pump rollout.	Amber	Green	Green	Amber	Red	Green	Red	Green	Green
Glazing upgrade is required in 70% of WCC owned properties in **Queen's Park Garden** area. With large share of terrace houses and WCC ownership, the area has been identified suitable for HP deployment, and improving the fabric efficiency could improve heat pump performance and efficiency. The area is also located in North Paddington Program.	Green	Amber	Green	Green	Green	Green	Green	Amber	Amber
Bayswater glazing upgrade – the area mainly includes private-owned low-rise flats and terrace house, where about 60% of properties having single glazing. The area is also identified suitable for heat pump rollout and upgrading windows would enhance the heat pump performance.	Amber	Amber	Green	Green	Green	Green	Red	Amber	Green
Elgin Avenue glazing upgrade - comprises about 900 old flats (mainly built 1900-1929) mostly private owned and 80% of properties needs glazing upgrade.	Amber	Amber	Green	Green	Green	Green	Red	Amber	Green
Church Street glazing upgrade - the area is largely dominated by WCC-owned flats (~750) where around 75% requiring a glazing upgrade. The area has a high fuel poverty level, and the properties could highly benefit from demand reduction through fabric improvement.	Amber	Amber	Green	Green	Green	Green	Red	Amber	Green
Lancaster Gate glazing upgrade – over 70% of properties in the area need a glazing upgrade. About 12% of properties are listed. However, the private ownership introduces complexities for fabric retrofit initiatives in the area.	Amber	Amber	Green	Green	Green	Green	Red	Amber	Green
Pimlico area includes high density of flats with generally poor fabric and the properties could benefit from **glazing upgrade** through both demand reduction and comfort improvement. However, it is also worth noting that as the area is in South Westminster Area Network (also known as SWAN) with an established decarbonisation strategy and a plan for heat network extension. Although, improving the fabric efficiency is	Green	Amber	Green	Green	Green	Green	Green	Amber	Green

Project name/description	Fuel poverty	Cost	Alignment across scenarios	Scalability	Data confidence	Speed of deployment	WCC influence	Deployment complexity	Additionality
necessary, the other projects identified could take precedence (the improvement to cavity walls may be sufficient in some cases).	Green	Amber	Green	Green	Green	Green	Green	Amber	Green
Retrofit opportunities in non-domestic buildings in the Marylebone area, with the potential for 4.6 GWh in energy savings achievable through glazing upgrades and cavity wall insulation. These buildings are situated within the Howard De Walden Estate, and shared ownership within this estate could accelerate the retrofit process. Furthermore, the proposed area is positioned within the Harley Street Business Improvement District.	Red	Amber	Green	Green	Amber	Amber	Red	Amber	Green
Domestic heat pumps in Queen's Park Garden area, where most of the properties are terrace houses, with about 950 WCC- owned properties. However, the properties are rather poor from energy performance and combining the heat pump rollout along with fabric upgrade is required. The area is also located in North Paddington Program.	Amber	Amber	Green	Green	Green	Amber	Green	Green	Green
Domestic heat pumps in Riverton Close with about 120 WCC-owned low-rise flats and terraced houses. Some building already benefited from communal heating; this could be an opportunity for a small-scale communal heat pump project as well.	Amber	Amber	Green	Green	Green	Amber	Amber	Amber	Green
Domestic heat pumps in Abbey Road area with a large number of detached/ semi-detached properties that reduce the space barrier for HP installation. However, the limited grid headroom could pose a challenge for large scale roll-out.	Amber	Amber	Green	Green	Green	Red	Red	Green	Green
Domestic heat pumps in the south Hyde Park area, there is potential for heating system decarbonisation through heat pump in about 300 private-owned terrace houses currently using gas heating	Amber	Amber	Green	Green	Green	Amber	Red	Green	Green
Domestic heat pumps in the **Bayswater** area mainly consisting of private housing low-rise flats and about 500 terraced houses.	Amber	Amber	Green	Green	Green	Amber	Red	Amber	Green
Domestic heat pumps in Chester Square area, primarily consisting of private housing with about 600 properties suitable for heat pump installation. Due to high number of low energy efficiency properties in this area, some level of fabric upgrade is needed prior to implementation.	Amber	Amber	Green	Green	Green	Amber	Red	Amber	Green
Non-domestic heat pumps west edge of Church Street heat network zone is a priority as it is important to establish in the heat network study which is currently ongoing whether these buildings will be viable for connection. If not carrying out heat pump installation is a low regrets opportunity. The area also has a high number of properties on WCC land assets making them an early focus for decarbonisation.	Red	Amber	Amber	Green	Amber	Green	Green	Amber	Green
Non-domestic heat pumps in Gloucester Square includes a large number of relatively small hotels, which generally suit heat pump technology due to often requiring both heating and cooling provision. The area is also identified for communal systems and is likely to use a combination of heat pumps at different scales to serve both individual and multiple properties. The economics between these two options was shown to be relatively marginal, and not being identified as a priority for heat network connection, means it is considered relatively low regrets to deploy either communal or individual heat pumps.	Red	Amber	Amber	Green	Amber	Green	Red	Green	Green
Non-domestic heat pumps in Thayer Street, South Molton Street and Albmarle Street. Both Grosvenor and Howard de Walden great estates have influence over the area. Whilst in general the West End is shown as a major heat network opportunity, the somewhat smaller building level demands in this area are relatively well suited to building level heat pump solutions. This makes it a lower regrets area for early decarbonisation of heating in the West End without relying on the long lead time of heat network deployment.	Red	Amber	Amber	Green	Amber	Green	Red	Amber	Green

Project name/description	Fuel poverty	Cost	Alignment across scenarios	Scalability	Data confidence	Speed of deployment	WCC influence	Deployment complexity	Additionality
Non-domestic heat pumps in Carnaby and Berwick Streets is a priority due to the high density of relatively small non-domestic buildings heated by gas boilers. There size of the heat demands associated with these buildings means they are unlikely to be the focus of a heat network, falling below the 100 MWh/yr demand threshold being promoted by DESNZ.									
Non-domestic heat pumps in South Audley and Mount Streets was shortlisted as although the overall counts are low they equate to a large percentage of properties being flagged as being suitable for heat pumps. Some of the area is also flagged as suitable for domestic heat pumps – but the higher threshold required to be a focus area for domestic heat pumps was not met. However, examining the area in further detail for both domestic and non-domestic heat pumps will be of value – ensuring the electricity network and any reinforcements this will be at the lowest cost.									
Non-domestic heat pumps in Shepherd Street (to the south of Curzon Street) is identified has a high density of non-domestic properties identified for heat pumps. These properties have a high share of pubs, cafes and restaurants. Being relatively small buildings they were not identified as priority for heat network connection and having a common use and building typology means a common approach for heat pumps can be considered.									
The **South Westminster Area Network** (also known as SWAN) is **a major heat network** that is current being pursued linking the existing Pimlico and Whitehall district heat networks and connecting other large demands in the area. The majority of heat is planned to be supplied from a large water source heat pump in the Thames. This aligns to the modelling outputs of the LAEP. It should be noted that property level and small communal systems will also be deployed in this area but that the majority of heat will come from SWAN.									
The area around the **South Kensington** area is currently being considered for a **heat network**, progressing through various feasibility stages. This would potentially connect the Royal Albert Hall, Imperial College London and other large institutions in the area such as the Royal College of Music with other key demands outside of Westminster – these include the Natural History Museum and the Victoria and Albert Museum.									
The **heat network** opportunity identified in **Oxford Street** could align with the Oxford Street program, which aims to improve the overall usability and apparency of Oxford Street. This gives an opportunity to align construction timelines to minimise disruption, which would be key for a heat network to be delivered in such a busy area. Heating and cooling demand and proximity to Hyde Park provides opportunity to explore ambient loop systems. It would help develop an evidence base for heat networks in these more challenging areas. There will, however, be challenges in aligning the timescales of the Oxford Street programme, given that the programme is already at an advanced stage.									
Heat network in Regent Street – this could combine with Oxford Street creating a spine for heat networks in this challenging area of Westminster for deployment. The Crown Estate are developing their own strategy and feasibility studies for heat network opportunities in their land, these have been integrated into this LAEP strategy. This area was also highlighted by the City of London of being in close proximity to substantial waste heat sources (notably data centres).									
St Mary's Hospital is undergoing major redevelopment. It is, and will continue to be, one of the largest single heat demands in Westminster. This makes the redevelopment a key opportunity to develop a **heat network** in the immediate area. This opportunity was flagged by AECOM in the Heat Network Zoning work being carried out for DESNZ.									

Project name/description	Fuel poverty	Cost	Alignment across scenarios	Scalability	Data confidence	Speed of deployment	WCC influence	Deployment complexity	Additionality
The **area next to St Johns Wood Station** has several large heat demands suitable for **heat network** connection, including St John and St Elizabeth Hospital, schools, nurseries and clinics. Due to a lack of WCC ownership and being in the area with grid constraints, this is not considered as an initial project. However, within the LAEP all properties need to decarbonise and in this area a heat network solution appears to be the most viable option.									
The east side of **Chippenham Road** is identified as a potential focus for **communal heating systems**, it characterised by relatively small blocks of flats. The limited space means deployment of heat pumps at a property level is likely to be untenable. This means they are not identified as good opportunities for heat network connection. This area has a lower presence of WCC assets than other communal networks identified.									
West end of **Sutherland Avenue** is a small priority area selected due to the very high proportion of buildings that are identified as being suited for **communal systems**. The area is in a conservation area and would be a good test for widescale deployment of communal systems addressing this constraint. The buildings are dominated by commercial space on the ground floor with flats above. This typology means a communal system can be cost effective, benefiting from the different heating profiles.									
Formosa and Crescent Gardens is again dominated by large terraces of historic multiple property buildings. Being relatively small building level heat demands the area is not highlighted as a focus for heat networks. The relatively extensive greenspace near many of the buildings does increase the possibility for **shared ground loop communal** systems.									
The **west of Abbey Road** was highlighted due to a high proportion of the properties (even though total counts are relatively usual) being identified as switching to **communal systems**. The lack of heat networks identified in the immediate vicinity make it a low regrets option and six communal boilers already in the area present an easy option for initial decarbonisation.									
Scott Ellis Gardens was identified as it has a high proportion of WCC ownership and three existing **communal** boilers to decarbonise. The majority of properties are WCC owned flats, meaning the greater influence can be used to help encourage an earlier switch. Additionally, the WCC owned land around the flats could help enable heat pump deployment.									
Gloucester, Connaught and Hyde Park Squares is a potential focus for **communal systems**, it does not have many large typical anchor loads for heat networks. However, it does have a large number of relatively small hotels as well as historic terraced domestic buildings with multiple properties as well as more modern flats. The former will likely be relatively easy (in terms of suitable building fabric) to switch to low carbon heating systems. There are already a large number of communal boilers in the area – allowing for relatively simple decarbonisation of multiple properties. It should be noted that in the High Heat Network scenario this was identified as a heat network area – with the large number of communal systems being aggregated to a larger network.									
Ennismore Gardens and Montpelier Square was identified as an area for **communal systems**. Despite being surrounded by areas identified for heat networks the buildings are generally domestic and do not reach a high enough heat threshold for connection to a heat network. Pursuing communal systems in the area also allows some early decarbonisation in the Knightsbridge and Belgravia ward without relying on heat network deployment.									

Project name/description	Fuel poverty	Cost	Alignment across scenarios	Scalability	Data confidence	Speed of deployment	WCC influence	Deployment complexity	Additionality
On and around **Dorset Street** is in an area which is identified to include a heat networks. However, the building in this area were relatively small in terms of heat demand and so not considered a priority for connection. Also, the mix between domestic and non-domestic properties will improve diversity and help optimize system sizing, making it a potential focus for **communal** systems.									
The area around **Great Titchfield Street** includes a mix of flats and non-domestic properties in the same building, suiting a shared system approach. Additionally, there are several WCC owned buildings and nine **communal** boilers presenting an early decarbonisation opportunity.									

Soma Mohammadi, Ben Aldous, Andrew Commin
Buro Happold Limited
17 Newman Street
London
W1T 1PD
UK

T: +44 (0)207 927 9700
F: +44 (0)870 787 4145
Email: andrew.commin@burohappold.com