BURO HAPPOLD

045172 Lewisham Energy Masterplan

STRATEGIC BOROUGH-WIDE DECARBONISATION

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Contents

Glossary

Term	Definition
ASHP	Air Source Heat Pump
BLE	Bakerloo Line Extension
DSR	Demand Side Response
EE	Energy Efficiency
EPC	Energy Performance Certificate
EV	Electric Vehicle
GLA	Greater London Authority
GSHP	Ground Source Heat Pump
HaaS	Heat as a Service
LBL	London Borough of Lewisham
LSOA	Lower Layer Super Output Area
LZC	Low/Zero Carbon
P2P	Peer to Peer
PV	Photovoltaics
V2G	Vehicle to Grid
VPP	Virtual Power Plant

Executive summary

Size of the challenge

Lewisham Council (LBL) declared a Climate Emergency in April 2019, with the aim of making the borough carbon neutral by 2030. Around 30% of Lewisham's total carbon emissions originates from the burning of natural gas in domestic boilers for heating and hot water production. Heating is therefore likely the largest single contributor to carbon emissions in the borough.

The Lewisham Climate Action Plan estimated costs of £1.6bn to deliver the scenarios needed to reduce carbon to a level that would make the net-zero 2030 target conceivable. Around 75% of the £1.6bn investment needed, relates to housing. Around 58% of the properties in the Borough have an EPC of D or below, to get all the properties to EPC of B by 2030 (as recommended in the Action Plan) would require a rate of retrofit of over 9,000 homes a year.

Buro Happold's heat mapping for the Energy Masterplan suggests that up to 35% of demands lies within a heat network opportunity area. However, it is estimated at least 80% of the heat demand across the borough will require alternative low carbon heat solutions at a building level.

Lewisham Homes manages 19,000 homes in the borough on behalf of the Council, much of which is known to have low energy efficiency standards. This is up to 15% of the residential stock in the borough – and therefore has a large role to play in decarbonisation of heat.

Emerging solutions

The technology options that are commercially ready and can deliver savings in the next 10 years are well understood. Heat pumps are likely to play a major role for the delivery of low carbon heat in Lewisham.

Heat pumps can provide high efficiency heat and in the right circumstances can off a cost competitive form of heating for gas boilers. The technology however operates most efficiently at lower temperatures than many of the existing building stock is designed for. Energy efficiency measures and/or changes to the heating systems will likely be required in many buildings to incorporate the technology. The following hierarchy in the decarbonisation of heat in Lewisham's building stock is therefore recommended:

1. Mean – reducing the need for heat. For example, retrofitting energy reducing measures such as wall and loft insulation, double glazing and draught-proofing.
2. Lean - supplying heat efficiently and at least cost to consumers. For example, larger heat emitters (radiators) to allow lower temperatures and installation of TRVs for better temperature control.
3. Green - Using renewable and low carbon heat. Introduction of low carbon technologies e.g. heat pumps and/or solar thermal.

In more densely populated areas, i.e. blocks of flats, the solutions could involve communal installations with relatively limited household intrusion for connection. In locations with lower density housing the solutions are more likely to be focused on individual properties, using electrically powered heat pumps.

Scaling up

On average the capital costs required to implement sufficient efficiency measures and low carbon technology are higher than the 'business as usual' approach e.g. gas boilers. There are a number of existing mechanisms and opportunities for others to help incentivise uptake.

Similar to a mobile phone contract, emerging business models such as 'Heat as a Service' or 'Comfort Plans' could help deliver larger scale change by offering customers the chance to benefit from higher levels of comfort and low carbon heat without an upfront capital outlay.

Single domestic users currently have access to the tariff based Renewable Heat Incentive (RHI) which can make heat pump installation quite attractive provided the customer has the upfront capital for the heat pump and that the property is suitably efficient to allow the operational temperatures required for heat pump integration. In March 2022 this will be replaced with a capital grant approach (subject to consultation) which, whilst overall less contribution than RHI, is an upfront grant which may incentivise uptake when gas boilers come up for replacement.

For larger scale deployment Lewisham can access low cost finance through schemes such as the Mayor's Energy Efficiency Fund (MEEF) as well as free support through the Retrofit Accelerator programme.

Digitalisation of energy infrastructure

The shift away from natural gas and increased electrification of heat alongside transport can create a strain on the power grid. As the largest housing provider in the borough, LBL have the potential to play a leading role in the transition to a digitised energy market. Without a coordinated approach, stakeholders will continue to make uninformed decisions which lead to system inefficiencies and increased cost. The benefits of a coordinated digitised approach are:

1. Give value to Lewisham residents through driving down energy costs and reducing consumption
2. Accelerate the role out of low carbon projects by reducing/eliminating the need for expensive, time consuming grid reinforcements – and increasing uptake of low carbon projects.

An infrastructure strategy plan is recommended to fully define and realise the benefit of digitalisation in Lewisham. Once the benefits of digitisation are quantified, along with a portfolio of projects to implement the benefits, LBL can work with the Greater South East Energy Hub and The London Economic Action Partnership (LEAP) who can act as a bridge between central and local government and can help attract third party investment. The infrastructure strategy plan could include the following elements:

- UKPN grid constraints analysis to understand where flexible energy trading may have maximum value
- EV charging strategy (including V2G)
- Quantify the generation potential: PV resource, energy storage, etc
- Supply potential: Lewisham Homes asset review, residents survey, private sector engagement, soft market testing

- How digital infrastructure could increase the supply potential (e.g. demand side response, HaaS, p2p trading)
- Develop a forward plan of what low carbon infrastructure needs to be installed to meet climate targets (including the proposed heat networks at Catford, Lewisham Town and Deptford)
- Portfolio of projects to take to third party investors
- Identify pilot projects which could see immediate benefits.

What can I do?

New builds

Any new buildings should be following the latest London Plan guidance on energy solutions whether a house or a block of flats. In short this means the following steps:

1. First minimise demands through fabric / efficient systems
    - A number of guidance suggests more ambitious design parameters than current building regulations that should ideally be targeted (e.g. LETI Climate Emergency Design Guide)
2. Introduce low carbon heat through heat pump based systems, with thermal storage (i.e. no gas boilers or direct electric heating systems)
    - Supplemented with solar PV / thermal where possible.

Residents of existing properties

Existing buildings should be following the same hierarchy as new builds:

1. First reduce demands through fabric / efficient systems – ensure the building is well insulated (e.g. double glazing, roof and wall insulation). This will mean implementation of lower carbon heating technologies can be implemented with minimal change to existing wet-heating systems
2. Introduce low carbon heat through heat pump based systems, with thermal storage (i.e. no gas boilers or direct electric heating systems). Some utility providers are offering heat pump solutions to their customers.
    - Supplemented with solar PV / thermal where possible.

It is acknowledged that there will likely be limitations for small blocks of flats due to ownership boundaries and lack of individual control for external measures; these properties will require multiple agreements across stakeholders. Where these are already well insulated, and planning / lease agreements allows, then flats may be able to implement individual heat pumps to replace existing boilers. Many new build flats have communal heating systems which makes technology switches easier.

For those harder to retrofit buildings to reduce energy demands and heating system temperatures required for heat pumps, a hybrid ASHP approach is seen as an interim solution due to the high carbon intensity of the gas grid.

Asset Management

For Lewisham Homes or any other portfolio holder in the borough, the following next steps are recommended:

1. Review assets to categorise and prioritise for heat decarbonisation

   e.g. due for refurb / plant replacement / area of high fuel poverty / worst performing EPC

2. Devise strategic plan for building energy reduction and heat / hot water decarbonisation by individual building or typology

   a. fabric improvements and heating system modifications to support lower temperatures

   b. review low carbon heat opportunities

   i connect to DHN

   ii install heat pump

3. Estimated costs for modifications/installation and operation (versus the current form of heating) to identify preferred option

Depending on the local resources and space availability the technology solution is likely to take the form of ground source or air source heat pump technology. A number of technical solutions are available for flats – e.g. individual heat pumps or communal systems – the case studies in this report present a number of these being implemented elsewhere in the UK.

1 The size of the challenge

1.1 Introduction

Lewisham Council (LBL) declared a Climate Emergency in April 2019, with the aim of making the borough carbon neutral by 2030. Heating is recognised as one of the major contributors to carbon emissions within the borough.

LBL have just undertaken an Energy Masterplan which identified opportunity areas for low carbon heat network deployment in the borough. A large proportion of the building stock across Lewisham does not fall within the heat network opportunity areas, this study therefore sets out a strategy for decarbonisation of heat across this stock.

The structure of the report is as follows:

- Size of the challenge
  - Lewisham building stock – a review of typologies, ownership and efficiency
- Emerging solutions
  - Hierarchy for heat decarbonisation
  - Technology assessment against key criteria
  - Applicability to building typology and tenure
- Scaling up
  - Funding streams and delivering wide-scale deployment.

1.2 Carbon neutral by 2030

The Lewisham Climate Action Plan estimated costs of £1.6bn to deliver the scenarios needed to reduce carbon to a level that would make the net-zero 2030 target conceivable. Just over 50% of the £1.6bn investment needed, £843m, relates to private housing. Social housing and Lewisham Homes accounts for a further £393m.

As a commuter borough, The London Borough of Lewisham (LBL) has a much higher percentage of carbon emissions arising from residential energy use (just over 50%) compared to the London average of 33% (Figure 1.1). Around 30% of Lewisham's total carbon emissions originates from the burning of natural gas in domestic boilers for heating and hot water production. Heating is therefore likely the largest single contributor to carbon emissions in the borough.

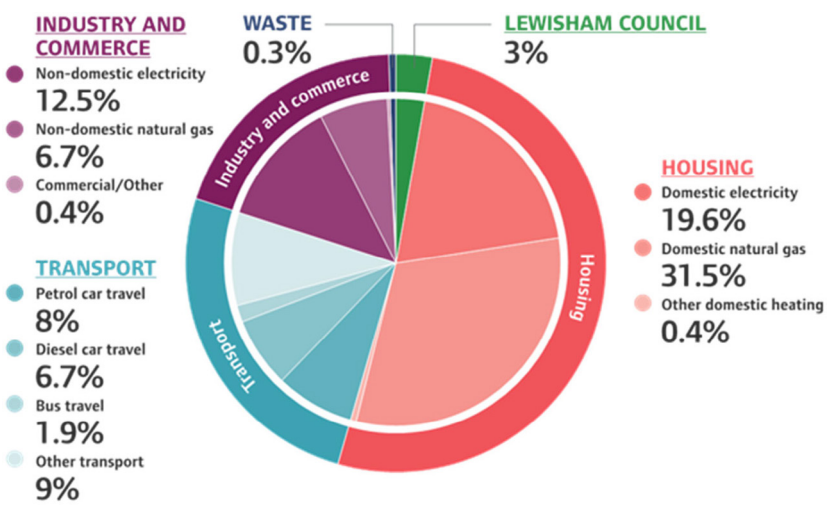


Figure 1.1: Split of carbon emissions in the borough (Lewisham Climate Emergency Action Plan)

The planned Bakerloo Line Extension (BLE) into the borough is likely to increase the demand for housing, particularly in areas further south, such as Catford and Bell Green, as they become more accessible to the city.

Large parts of the housing stock in the borough was built in an era when coal was the primary source of heating. Older, draughty, inefficient homes cost more to heat and Government statistics show that over 13,000 Lewisham households (11%) fall below the threshold for fuel poverty, and are unable to keep their home warm enough.

Lewisham Homes manages 19,000 homes in the borough on behalf of the Council, much of which is known to have low energy efficiency standards – this is up to 15% of the residential stock in the borough – and therefore has a large role to play in decarbonisation of heat.

Buro Happold's heat mapping identified a total of 810 GWh/a across the borough, 35% of which lie within a heat network opportunity area. This excludes small residential and retail properties. As not all these loads will be suitable for connection to the heat network, it is estimated at least 80% of heat demand in the Borough will require alternative low carbon heat solutions at a building level. This is illustrated in Figure 1.2 which shows the heat loads in the borough (sized to annual demand), with the heat network strategic corridor shown in pink.

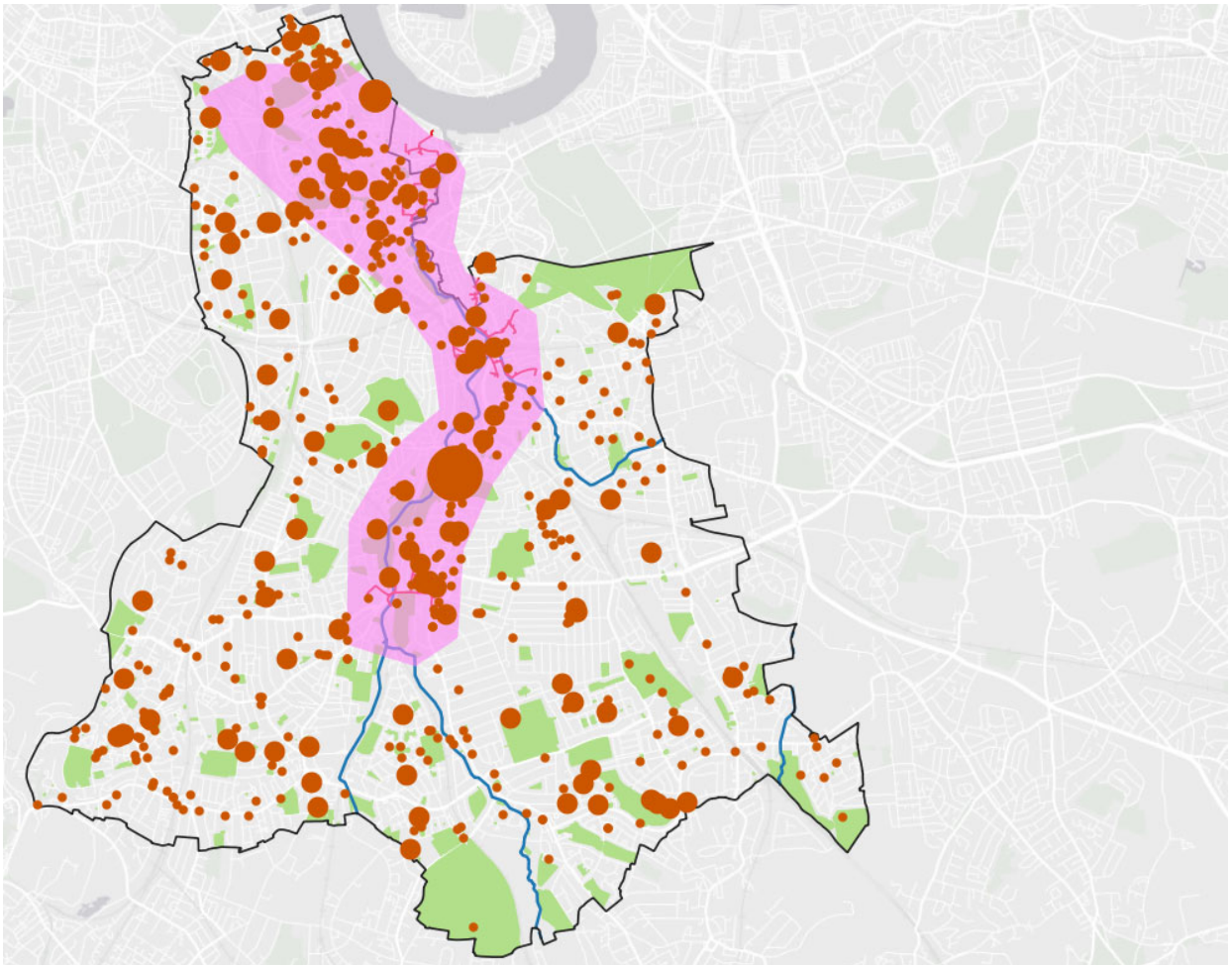


Figure 1.2: Borough wide heat map with heat network opportunity area

1.2.1 Low carbon heating technologies

The selection of technologies for the longer term will depend on a number of variables including:

- Market conditions for fuel;
- Maturity and development of technology;
- CO2 intensity of the electricity grid.

BEIS provides annual carbon emission factors for all fuels used in the UK as well as annual future projections for the carbon emission factor of power grid electricity. The penetration of renewable power in the UK has been increasing and is projected to continue to increase over the coming decades. Along with nuclear power and potentially carbon capture and storage (CCS) this is projected to drastically decarbonise the national electricity grid

As such, technologies such as gas-fired CHP and gas boilers are already becoming more carbon-intensive than electrified heat options such as heat pumps (see Figure 1.3). Whilst there is expected to be some greening of the gas grid over the next 10 years this is not anticipated to be substantial and this has led to the Committee on Climate Change to recommend that no new homes are on the gas grid by 2025.

Green hydrogen is billed as a potential solution for those harder to reach buildings, but schemes are only at pilot stage with large scale trials in the UK not set to be complete till the early 2030s. Wide scale deployment of a green hydrogen network is therefore likely at least 20 years away (if it ever comes) – requiring successful pilots, upgrades to the gas grid as well as enough excess renewable generation to generate sufficient volumes of hydrogen to replace the gas grid.

Similarly, whilst biomass boilers can offer large carbon savings there are air quality concerns with their use in London in particular around fine particle pollution. On the domestic level there are logistical issues and ensuring that owners are sourcing renewable sources of biomass that deliver true carbon savings. For these reasons it is omitted from this study.

Electrification of heat is therefore essential for decarbonisation by 2030.

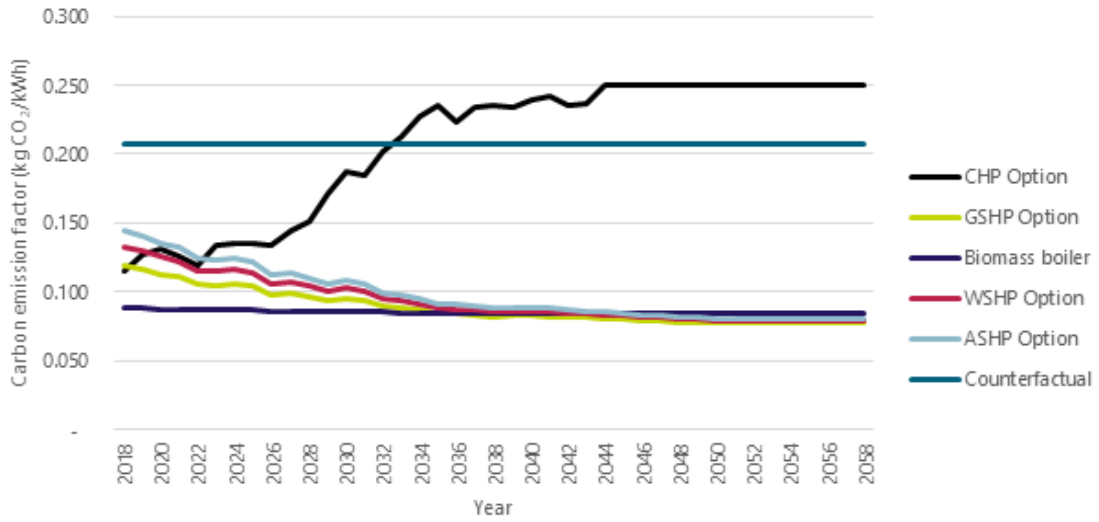


Figure 1.3: Carbon factor model to 2055 based on typical efficiencies and using BEIS projected carbon factors

1.3 Existing stock

1.3.1 Building typologies

Lewisham consists of a large range of building architypes and owners. To the north of the borough and along its central spine there is relatively high-density housing, mostly consisting of flats. The high-density areas also house the majority of LBL's retail and business companies. Whilst up to 60% of the properties across the borough are flats – some of this is converted flats and the remaining are houses. Figure 1.4 highlights that particularly in the south-east properties are majority housing.

1.3.2 Building tenure types

Over 30% of properties in the borough are either Council or Social owned – this provides the easiest area to focus decarbonisation efforts in the short term as LBL have more control over implementation.

However, one in four residents in Lewisham live in the private rented sector, and around half own their own home. These properties will typically be more difficult to decarbonise as leaseholders / freeholders typically take a more short-term view whilst landlords may not want to make more expensive changes to impact their returns.

1.3.3 Heating provision across the borough

Around 90% of the borough are on Gas, Oil or Solid fuel heating with boiler as the primary technology. The majority of the remaining properties within the borough are on storage or room heaters – these are electrically heated but expensive to run as electricity costs 4 to 5 times the price of gas.

A minority are on other heating systems such as communal systems or heat pumps.

1.3.4 Building efficiencies

At least a third of the building stock is built pre 1930s and over two thirds pre 1982. This typically means buildings are less efficient as building regulations at the time were much less stringent. This is highlighted in the Energy Performance Certificates (EPCs) data - an established tool for measuring the energy performance of buildings – which tells us that 57% of the borough properties are EPC band D or below.

Data on the Crohm portal shows that in 2012 71% of homes had an EPC of D or below. This represents an increase in building stock efficiency of approximately 15,000 homes over the eight years – a rate of c1,900 homes per year.

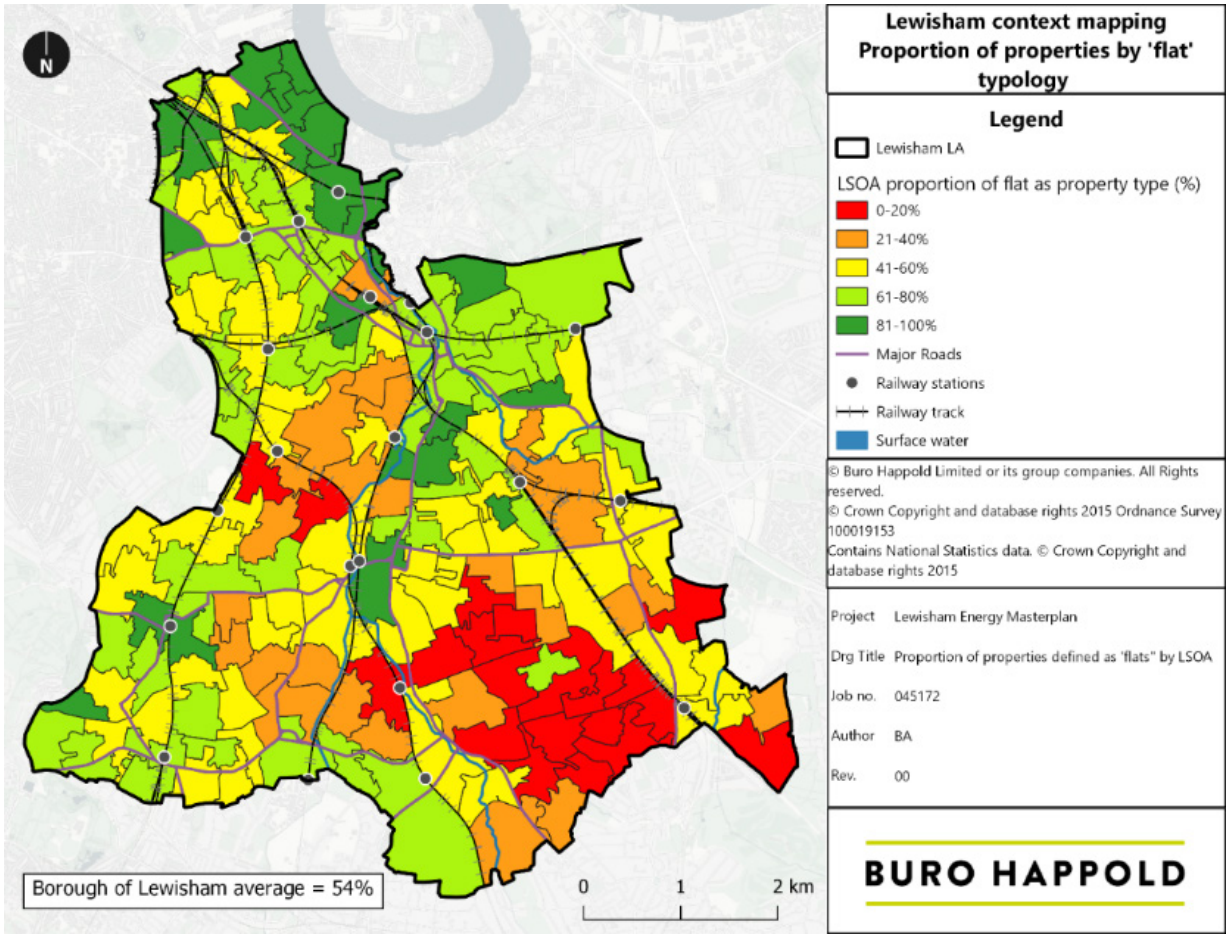


Figure 1.4: Percentage of properties which are flats across the borough, mapped by LSOA

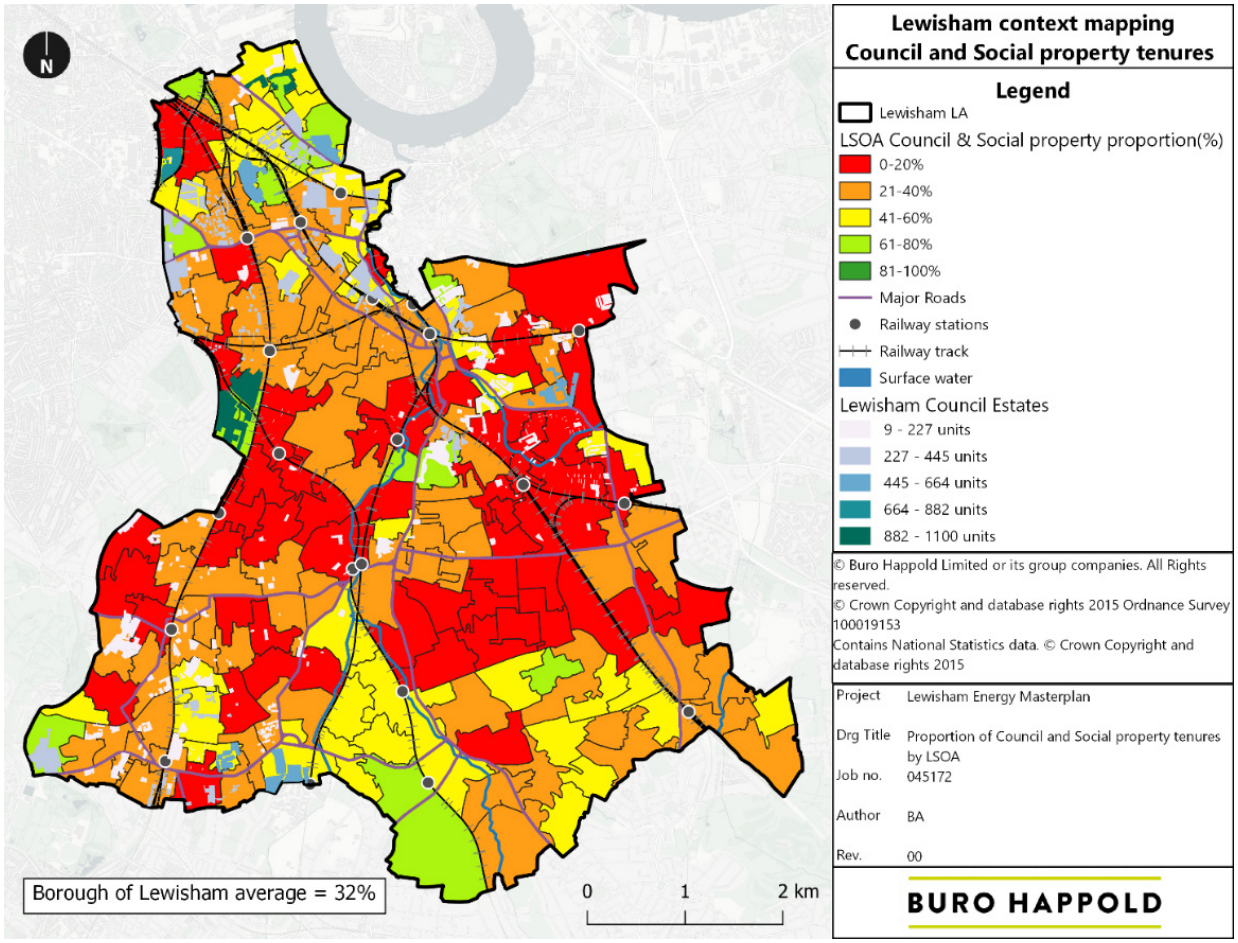


Figure 1.5: Proportion of council and socially owned properties

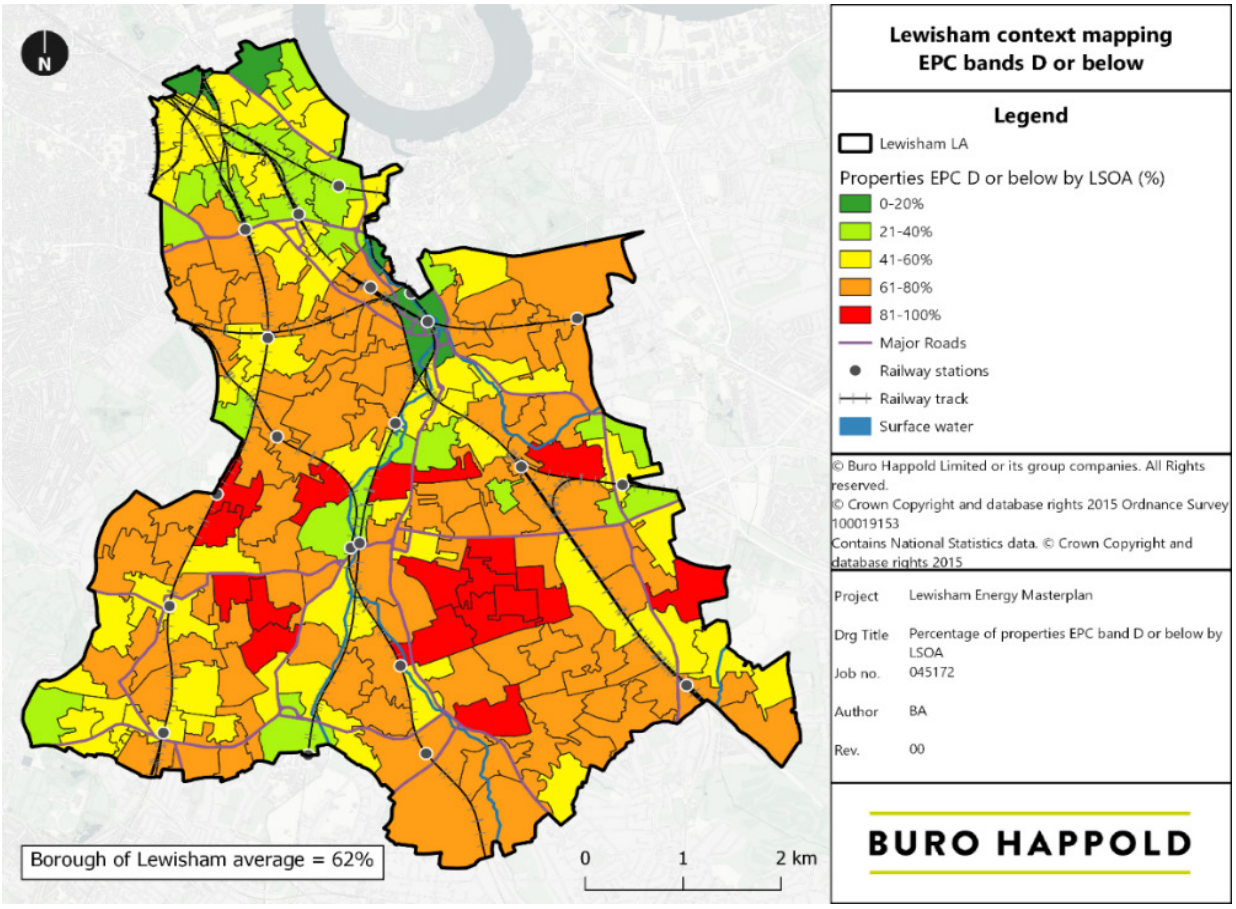


Figure 1.6: Proportion of properties with EPC rating D or below

1.3.5 The scale of retrofit in Lewisham

Lewisham's Climate Emergency Action Plan states all residential properties in the borough should be retrofitted to EPC of B or above by 2030 in order to meet carbon targets.

Currently, only 13% of Lewisham's building stock is rated B or above. By implementing basic energy efficiency measures, this could be increased to 34% (Figure 1.7). To achieve this requires a retrofit roll out of approximately 2,200 homes per year to 2030 – just above the existing rate in the borough.

However, a strategy needs to be developed to bring the remaining 70,000 hard to tackle homes up to modern energy efficiency standards. To achieve this by 2030, an additional 7,000 homes need to be retrofitted every year.

The total rate of retrofit required on existing homes to 2030 is summarised in Figure 1.8, split by tenure type. This totals c90,000 homes over 10 years.

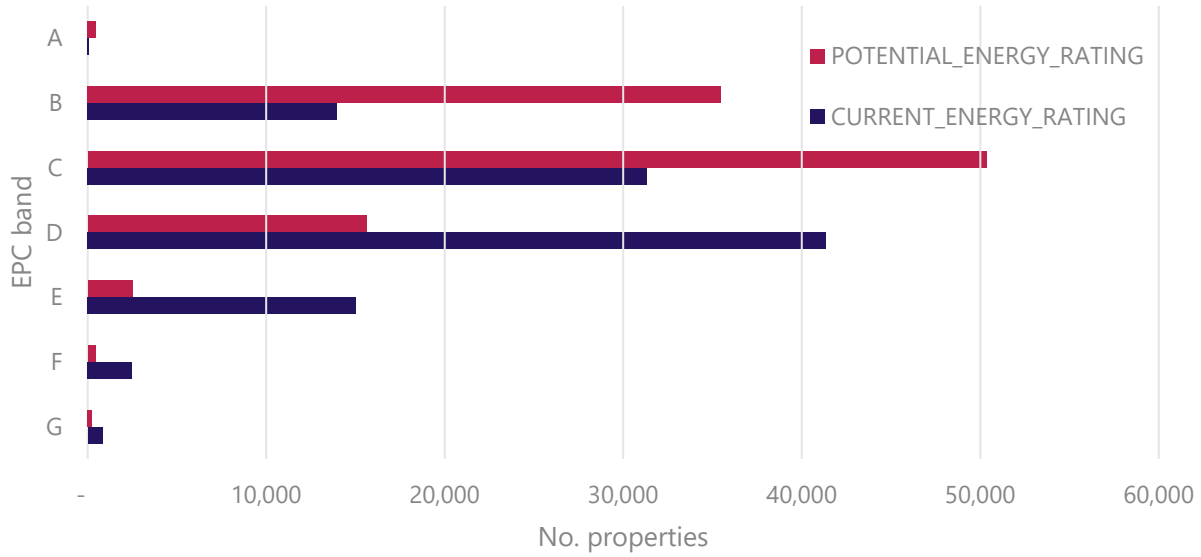


Figure 1.7: EPC rating current and potential

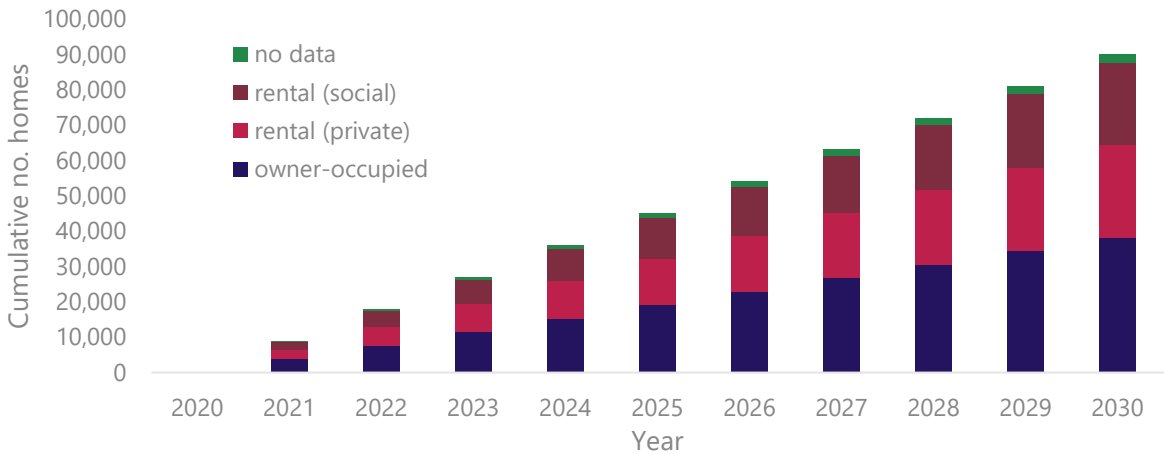


Figure 1.8: Rate of retrofit required to 2030 to reach EPC B or above

1.4 Key Constraints

Tenure types

Table 1.1: Tenure types

	Owner occupied	Social rented	Private rented
Incentives	The owner-occupied market are likely to be most concerned with capital cost. Incentive to increase value of home. Reducing energy bills may also be an incentive.	Energy bill reductions.	Energy bill reductions. Owner – higher rental yields / unique selling point
Constraints	Lack of capital. Existing boilers still in good condition. Intrusive measures required. Flats have a number of owners – multi stakeholders agreement required.	LBL may own freehold to flat building but not 100% of leasehold – multi stakeholders agreement required. Level of intervention/ disruption to daily life depending on solution.	Low level of influence and low incentives for landlord. Regular change in occupancy. Level of intervention/ disruption to daily life
Opportunities	Low carbon agenda now much higher priority for public than historically. Increases property value. RHI (or future replacement) / ECO funding.	Reduce fuel poverty. High level of influence from LBL.	Better design could lead to improved rental yields for owner.

Grid capacity

The uptake of electrification of heat will put a strain on the electrical grid. UKPN have been approached for information on the capacity across the borough however have not provided any data to date.

Conservation areas

A number of areas in the borough are conservation areas which may mean restrictions on certain heat pump solutions which may have a visual impact and therefore subject to planning constraints.

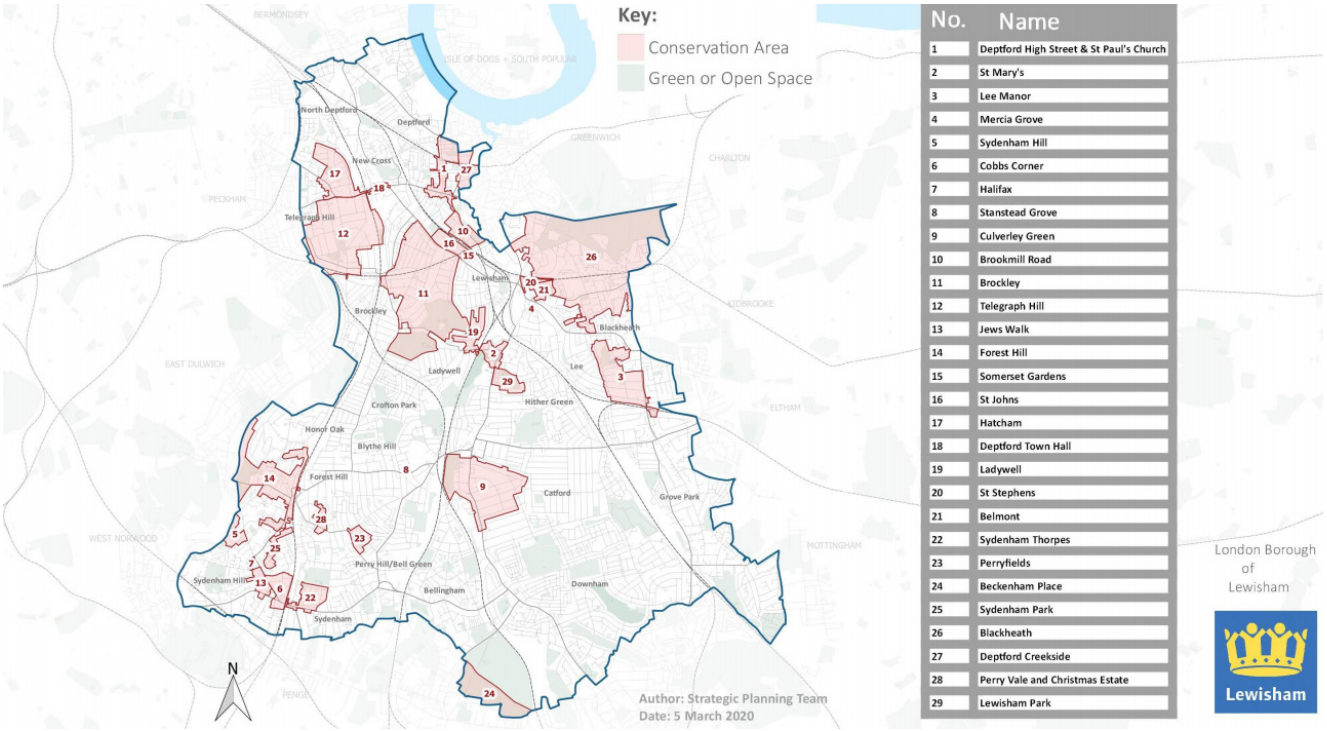


Figure 1.9: Borough wide conservation map 2020

2 Emerging solutions

2.1 Technology assessment – low carbon heat

There is no single clear technology answer for low carbon heat however to meet a 2030 carbon neutral target then the systems chosen need to be 'technology ready' for deployment over the next 10 years. The core low carbon technologies available to Lewisham's building stock that can deliver long-term carbon savings are therefore:

Technology	Description / comments	Capital costs	Operational costs	Future energy prices	Future decarbonisation	Technology risk	Funding opportunities	Space and access	Overall score and comments
Air Source Heat Pump (ASHP)	Varying performance with ambient conditions, infinite supply, becoming a widely used low carbon technology. Can be per individual dwelling (e.g. flat or house) or communal (e.g. block of flats, with on-site network to heat interface units in each dwelling)								
Ground or Water Source Heat Pump (GSHP)	Requires open space for installation – likely limited applicability in houses but could suit flats. Higher efficiency (and therefore carbon savings) than ASHP. Open loop requiring detailed ground survey but reliable, closed loop offering compact installation.								
Communal GSHP	Shared ground array with individual heat pump in each property can make installation more cost-effective.								
Hybrid gas heat pumps	Same as an ASHP but with a gas boiler integrated within the system. A potential transitional technology – allows a level of decarbonisation without energy efficiency improvements to the building.								

Technology	Description / comments	Capital costs	Operational costs	Future energy prices	Future decarbonisation	Technology risk	Funding opportunities	Space and access	Overall score and comments
Direct Electric Heating	Simple and cheap solution; however is 2 to 4 times less efficient than heat pumps = much higher running costs and lower carbon savings								
Solar thermal panels	Cheap and simple solution for hot water production. Require south-facing roof space and large internal space for hot water cylinder. They can integrate with ASHP where space is available								
PV	When combined with any of the electrical heating measures they can reduce operational costs, improve carbon performance. Thermal storage coupling can act like a heat battery - storing daytime PV generation as hot water for later use within the building.								

2.1.1 A whole system approach

A whole system approach to energy infrastructure can maximise the cost and carbon benefits of installing low carbon technology. Figure 2.1 illustrates this approach in low rise housing retrofit. By combining solar PV and thermal storage, low carbon electricity can be generated to supply the heat pump at times of high grid carbon intensity or prices. This heat produced can be stored in a hot water cylinder to be utilised when needed. Fabric retrofits and increased insulation mean the system can operate at reduced temperatures, increasing the efficiency of the heat pump and producing significant cost savings.

In addition to this, battery capacity can be installed to allow peer to peer (P2P) electricity trading at a local level or to facilitate the implementation of a wider Virtual Power Plant (VPP). This is explored in more detail in Section 2.3.

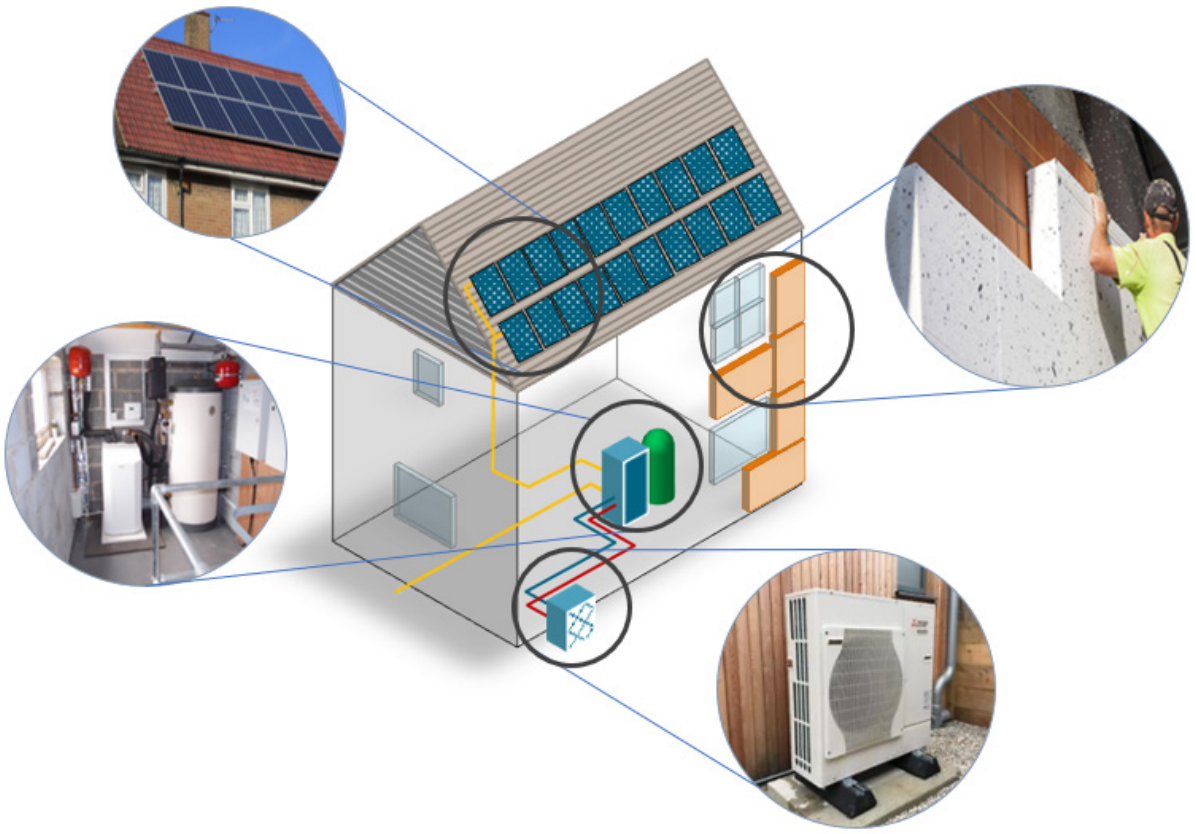


Figure 2.1: Whole system retrofit example: air source heat pump, solar PV and fabric retrofit

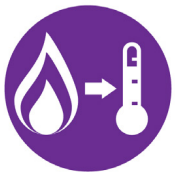
2.2 Heat decarbonisation hierarchy - Mean, Lean, Green

For efficiency reasons, many low carbon heat sources, such as heat pumps, need to operate at lower temperatures than traditional gas fuelled technologies. This will require widespread implementation of energy efficiency measures in the existing building stock. This applies to both buildings with proposed heat network connection and those outside the opportunity areas.

The “Mean Lean Green” philosophy aims to produce developments, existing and planned, that minimise the demand for resources and provide efficient structures to deploy innovative technology. This approach is in line with the GLA’s heating hierarchy for planning of new developments and it is proposed that such an approach is pursued in decarbonising heat within the borough.

1. Mean – reducing the need for heat.

Reducing the demand for heat. For new builds, creating guidelines for building designers to ensure demand is low from the outset, by utilising fabric first approach and passive measures such as external shading. For existing buildings, includes retrofitting energy reducing measures such as wall and loft insulation, double glazing and draught-proofing.



2. Lean - Supplying heat efficiently and at least cost to consumers.

For example, reducing distribution losses for energy between generation and usage. This might involve increasing building system efficiency by replacing inefficient high temperature heating systems with newer low temperature alternatives (e.g. larger radiators or underfloor heating) which also enables low carbon technology integration.

3. Green - Using renewable and low carbon heat

Supplying any remaining requirements from renewable sources to minimise residual carbon emissions. For example, decarbonising heat supply through solar technologies and heat pumps.

Figure 2.2: Mean, Lean, Green hierarchy

Electrifying heat through maximising heat pump installations will led to a significant increase in local electricity consumption across the borough. The capacity constraints on the existing distribution grid are likely to impede the roll out rate of heat pumps as well as lead to large, costly civils projects to reinforce the grid infrastructure.

There are multiple ways to address these problems by looking at the system at a larger scale. The growing digital infrastructure sector can be utilised to provide connectivity between distributed energy supply and demand that was not possible in tradition energy markets. Detailed in Section 2.3, various forms of flexible energy trading can allow increased uptake in electrified heating without expensive physical infrastructure upgrades.

2.3 Case studies

2.3.1 Enfield, London

Typology	Decarbonisation Measures	Decarbonisation Strategy
High-rise Flats	Ground Source Heat Pump (GSHP)	400 flats over 8 tower blocks in Enfield, were retrofitted using a shared ground loop array ground source heat pump system with individual heat pumps in each dwelling

Enfield Council own freehold of the tower blocks, with a number of private leaseholders. In 2017 Engie were appointed to deliver this scheme in partnership with Kensa Contracting. 16 boreholes serve the eight blocks with an individual 3kW Kensa Shoebox GSHP and hot water cylinder installed in each flat (see Figure 2.3). The project also included external wall insulation in two of the blocks, identified through thermal imaging surveys.

The scheme will deliver an expected 30-50% saving on residents heating bills compared to the electric heating previously installed. Funding was secured through ECO and RHI.

This solution is potentially well suited to purpose-built flats with electric heating. Lewisham Council own a number of blocks where this solution may be applicable, with an approximately 7,000 homes in the borough currently using storage heaters.

Borehole layout | Heat pump & hot water cylinder | Block level | External works

Figure 2.3: Mean, Lean, Green hierarchy

2.3.2 Swaffham Prior Cambridge

Typology	Decarbonisation Measures	Decarbonisation Strategy
Low-rise housing	Ground Source Heat Pump (GSHP)	70% of homes are heated by burning oil. Swaffham Prior Community Land Trust are developing a closed-loop GSHP heating network for the area with the hope that 60-100% of properties will connect to it. A minimum of 170 homes are required to connect to make it a viable scheme. This will reduce annual carbon emissions by 66%.

This solution can be adapted in Lewisham were low density housing is located near a Council owned, unprotected open space. As most of the properties are likely to be owner-occupied it will require a lot of stakeholder engagement to ensure connection agreements are made prior to construction.

Note that this scheme is made more viable by the fact that oil is the existing technology and more expensive for users to run than gas. The Clean Heat Grant scheme, currently under consultation, to replace RHI hopes to make shared ground loops remain an attractive and therefore it could be viable for lower density housing in the borough.

2.3.3 Derby, Derbyshire

Typology	Decarbonisation Measures	Decarbonisation Strategy
High-rise Flats	Air Source Heat Pump (ASHP)	Rivermead House (54 units) had ageing electric heaters than required replacement and wanted a more cost-effective and environmentally friendly solution. A 5kW ASHP was installed on the balcony of each unit.

For well insulated flats in Lewisham (EPC > D), installing a small ASHP on existing un-used balcony space creates a cost-efficient alternative to whole building secondary system retrofit. This option is particularly beneficial if the building has a mixture of freehold and leasehold properties, as retrofit is carried out on a flat-by-flat basis.

2.3.4 Warrington, Cheshire

Typology	Decarbonisation Measures	Decarbonisation Strategy
Low-rise detached house	Air Source Heat Pump (ASHP) and Solar Thermal panels	Retrofitting gas boiler with an ASHP unit as well as a mixture of solar thermal and PV solar panels.

As above, this solution works well for well insulated owner-occupied homes (EPC > D) where no fabric retrofits are required. Here the ASHP unit is meeting the space heating demand, with solar thermal collectors supplying heat for hot water. If roof space allows, PV panels can be installed to meet a portion of the heat pump's electricity use.

A package solution can be offered to Lewisham homeowners that includes the installation of all plant equipment with guaranteed energy bills and carbon savings (see Section 3).

2.3.5 Nottingham

Typology	Decarbonisation Measures	Decarbonisation Strategy
Low rise housing	Ground Source Heat Pump (GSHP)	A successful pilot of 17 council owned Energiesprong retrofits in Nottingham has resulted in the rollout to retrofit an additional 155 hard to heat homes within the area. The rollout plans for communal energy centres with GSHPs fed by solar PV.

The Energiesprong solution (described in more detail in Section 3) can be utilised on Lewisham's most inefficient and hard to target buildings. Energiesprong UK offer whole system retrofits as a package, so far targeted at Local Authorities but they are looking to expand into the private sector.

2.3.6 Bridgend, South Wales

Typology	Decarbonisation Measures	Decarbonisation Strategy
Low rise homes	Hybrid gas-electric heating	The Freedom Project is being trialled in Bridgend, where 75 homes have been retrofitted with a 5kW ASHP which operates alongside the existing gas boiler. The system uses smart controls to take advantage of time-of-use price differences between the two fuels .

This solution is aimed at low density housing. By retaining the existing gas boiler for peak times, a smaller ASHP can be installed, reducing capital costs. This configuration has also been seen to increase consumer confidence in a technology not yet well understood in the general public, as they are not 100% reliant on the ASHP.

Smart controls are installed so the customer can monitor plant operation and energy use. A hybrid ASHP approach is seen as an interim solution due to the high carbon intensity of the gas grid – overtime buildings should be retrofitted to accommodate lower carbon solutions.

3 Scaling up

3.1 Factors preventing uptake

A survey carried out for the GLA Heat Pumps in London study suggested that some of the main perceived issues holding back wider scale deployment are:

1. Lack of user/client awareness
2. Capital costs
3. Mechanical design / technical feasibility
4. Architectural integration / visual impact
5. Electricity grid limitations

In 2016 an energy efficiency study was carried out to assess the scale of the energy efficiency market in Lewisham and identify the methods and mechanisms to maximise uptake across the borough . To avoid repetition of this work, the following section instead focuses on the funding and mechanisms available to maximise low carbon heat technology uptake across the borough.

3.2 The digitalisation of the energy sector

The energy market is poised for a big shift in the way customers sell and consume energy, across heating, cooling and power. Digitalisation is the key to this change, as the UK transitions from large thermal power plants to intermittent renewable energy generation and tackles local constraints in grid capacity.

The section below gives detail on the direction of the UK energy market models and the role LBL can play in the transition.

3.2.1 Demand side response

Smart Demand Side Response (DSR) systems will allow customers to remotely control the amount of heat provided to their homes and at what times throughout the day. When this is paired with time-of-use tariffs, consumers can minimise costs while contributing to peak load shifting, thus easing constraints on local power grids.

3.2.2 HaaS

Heat or Comfort as a Service (HaaS / CaaS) is also likely to play a part in this future market. Explained in more detail in Section 4.3, HaaS offers customers a package deal on their energy bills in the form of a guarantee of “warm hours” rather than traditional kWh billing. Trials of this have shown increased customer satisfaction and increased uptake in low carbon technology installations.

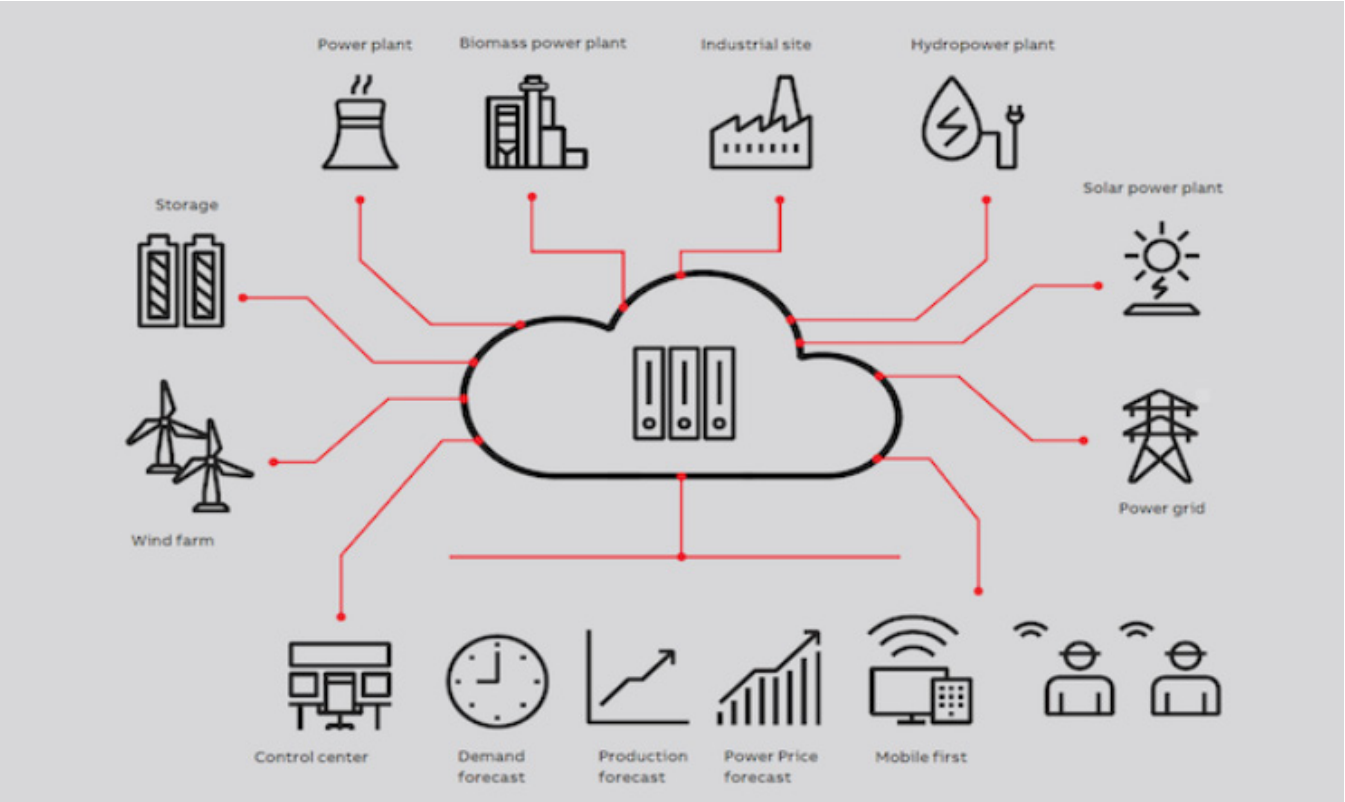
This combination of shifting energy supply structures alongside low carbon technology retrofits is likely to accelerate the decarbonisation of domestic energy use while minimising constraints on existing transmission and distribution networks.

3.2.3 Virtual power plants

A Virtual Power Plant (VPP) allows generators and customers to contribute to making a more stable, low carbon distribution networks, as well as maximising the benefits of time-of-use tariffs. VPPs are a digital control system that connects generators, energy storage and customers. Wireless controls mean that small adjustments can be made across these assets to balance supply and demand.

These live adjustments are small and can be controlled automatically so there is no interruption to normal activities. For customers this is achieved through installing wireless control boxes to existing meters. The customer will benefit from lower energy bills with no active energy management participation.

VPP operators do not own the generation plants. Instead they optimise how each asset (independently owned by a third party) is used. The cluster of individual assets is operated by a central control system which can react quickly and efficiently to price signals and adjust operations accordingly.



https://iiot-world.com/connected-industry/business-models-and-market-participation-for-virtual-power-

3.2.4 Case studies

London's first virtual power plant

In March 2020 a UKPN trial using household batteries to support London's electricity grid was rolled out to 45 homes . So far, the trial has reduced household peak electricity demand at the connected households by 60% and helped cut carbon emissions from electricity by 20%. A second phase of the scheme is now being rolled out by Powervault, a government-backed company who produce the battery system .

West Sussex virtual power plant

In West Sussex, Moixa are creating a virtual power plant (VPP) linking solar panels, batteries and electric vehicles in hundreds of homes, schools and council buildings in Worthing and Shoreham in West Sussex.

The company is part of a consortium of UK technology leaders that has secured £13 million from the government's Industrial Strategy Challenge Fund to show how cutting-edge power, heating and transport technologies can work together to cut energy bills, reduce carbon emissions, and help manage the electricity system more efficiently.

The VPP will include a marine source heat pump and combined heat and power system; a grid-scale battery using second-life electric car batteries; air source heat pumps supporting domestic boilers; and a hybrid refuelling station supporting electric vehicles and hydrogen fuel cell vehicles at nearby Horsham. Key capacity on the network includes:

- 1MW of spare capacity from batteries in homes, schools and council offices
- 1MW of electric vehicle capacity (across 250 electric vehicle chargers)
- 4MW of generation and 4.2MWh of storage from solar PV panels and batteries in 250 council homes and 100 schools and council buildings
- 2MW marine source heat pump – supplying heat to over 1,000 homes in Shoreham
- Air source heat pumps will be installed alongside gas boilers in 250 homes in Shoreham
- A hybrid vehicle refuelling station at Horsham will offer rapid charging to electric vehicles and will support vehicles powered by hydrogen fuel cells, such as those used by the Brighton and Hove Metrobus fleet. It will be the first of its kind in the UK, with a grid connection backed-up by a 2MW solar carport and storage from a 1MW hydrogen electrolyser.

The three-year project totalling £40m is supported by West Sussex County Council and the Carbon and Energy Fund. It is expected to cut home energy bills by up to 40% and save nearly 2,000 tonnes of carbon emissions every year .

Peterborough Integrated Renewables Infrastructure (PIRI)

Peterborough Council are leading a £2m scheme to provide green heat, electricity and transport to residents. The two-year Peterborough Integrated Renewables Infrastructure (PIRI) project began in 2020 in partnership with SSE Enterprise, Element Energy, Cranfield University, Smarter Grid Solutions and Sweco UK. It will be paid for through Research and Innovation (UKRI) funding and private sector investment .

The aim of the project is to reduce energy bills to consumers through providing a more flexible energy system that will enable more renewable generation onto the local grid and support the shift to Electric Vehicles (EVs). The project will also see battery capacity installed into homes and businesses to encourage flexibility of energy use and reduce peaks on the local grid.

Vehicle to Grid charging

In addition to home battery storage, EV batteries can provide short-term storage of surplus energy and provide essential grid balancing services . A Vehicle to Grid (V2G) charger works by selling excess energy back to the grid when demand is high and provide charging when there is surplus energy generation. EVs are currently parked 96% of the time, giving ample time for V2G interactions .

The UK company OVO Energy is leading the first large-scale Vehicle to Grid (V2G) project with Nissan. The first charger was installed in December 2018, with funding for 1,000 households to take part in the two-year initiative . Participants are able to control charging schedules, set minimum charge levels and see live data through an app.

The V2G model could be more widely applied to other electric transport such as e-bikes, e-scooters and e-buses, which are currently experiencing a rapid demand increase. For this to become viable there needs to be a huge increase in public charging networks which allow two-way connection to the grid when idle.

Peer to peer trading

In 2019 EDF Energy led an eight-week Peer to Peer (P2P) energy trading scheme in Brixton. This allowed residents of a social housing block to trade energy generated by roof-top PV stored in domestic batteries. The interactions can be controlled through an app using blockchain technologies for tracking trades.

Under current regulations, customers cannot buy from, or sell to, other consumers but delivery of the project has been made possible as part of Ofgem’s ‘Innovation Link’ . Permanent changes to this regulation would help unlock this innovation.

This project illustrates how small communities in dense urban areas can benefit from a smart low carbon, local energy system.

3.2.5 The role of Lewisham Council

As the largest housing provider in the borough, LBL have the potential to play a leading role in the transition to a digitised energy market. Without a coordinated approach, stakeholders will continue to make uninformed decisions which lead to system inefficiencies and increased cost.

The core benefits of a coordinated digitised approach to the energy in Lewisham are:

1. Give value to Lewisham residents through driving down energy costs and reducing consumption compared to the counterfactual
2. Accelerate the role out of low carbon projects by reducing/eliminating the need for expensive, time consuming grid reinforcements.
3. Increase in uptake of low carbon infrastructure prokects to meet climate emergency targets sooner.

LBL can position themselves to leverage benefits as a coordinator of a digital system. Positioning themselves as the only trusted body with an oversight of both the generation and consumer potential within the borough, LBL can use this unique perspective to coordinate planning with customers and suppliers. Through this, there is much higher chance to implement the large-scale change needed to meet the climate emergency targets.

Recommended next steps and future work

An infrastructure strategy plan is recommended to fully define and realise the benefit of digitalisation in Lewisham. Once the benefits of digitisation are quantified, along with a portfolio of projects to implement the benefits, LBL can work with the Greater South East Energy Hub and The London Economic Action Partnership (LEAP) who can act as a bridge between central and local government and can help attract third party investment.

The infrastructure strategy plan could include the following elements:

- UKPN grid constraints analysis to understand where flexible energy trading may have maximum value
- EV charging strategy (including V2G)
- Quantify the generation potential: PV resource, energy storage, more detailed look at Catford, Lewisham Town and Deptford potential
- Supply potential: Lewisham Homes asset review, residents survey, private sector engagement, soft market testing
- How digital infrastructure coordination could increase the supply potential (e.g. demand side response, HaaS, peer to peer trading)
- Develop a forward plan of what low carbon infrastructure needs to be installed to meet climate targets (including the proposed heat networks)
- Develop a portfolio of projects to take to third party investors
- Identify pilot projects which could see immediate benefits.

3.3 Funding

Retrofit accelerator

The programme will provide London boroughs and housing associations the technical expertise they need to kick-start ‘whole-house’ retrofit projects across the capital. It will also help build the supply chain and business case to accelerate the retrofit revolution for private homes .

The programme is focused on deep carbon retrofit, which could be houses or flats, and includes district heating. The offer is fully funded technical support to look at existing housing stock – i.e. stock analysis, business case development, procurement support, funding, project delivery, monitoring and verification. The programme does not decide the technical solution, focusing instead on the performance outcomes required. No capital funding is provided.

ECO

The Energy Company Obligation (ECO) is a government energy efficiency scheme to reduction carbon emissions and reduce fuel poverty. This funding stream is aimed at retrofitting old, inefficient housing. The main eligibility criteria is dwellings with an EPC rating of E or below.

With the ECO scheme it is possible to get:

- Free cavity wall insulation
- Free loft insulation
- A subsidised gas boiler replacement

MEEF

The Mayor’s Energy Efficiency Fund (MEEF) provides flexible and competitive finance as well as other funding options to aid delivery of new low carbon technology, over an investment period of 20 years. This is part funded by the GLA through the European Regional Development Fund (ERDF).

MEEF can support energy efficiency, decentralised energy, and renewable energy generation projects, including innovative technologies . Key metrics include:

- £500m fund size
- Invest across the capital structure, with rates as low as 1.5% for up to 20 years
- £2m of technical support funding available to support a projects business case

Carbon offset fund

Where the London Plan carbon reduction targets for new developments cannot be met (due to technical or commercial feasibility), developers must contribute to a carbon offset fund which will go towards funding the off-site CO2 reduction measures.

For all major developments (above 10 residential units or GIA of over 1,000m2), the financial contribution is based on the product of an established price (the GLA currently recommends £95/tonne per year) and the shortfall in CO2 tonnes saved below the minimum threshold over 30 years.

The revenue received by LBL from this is ring fenced for off-site carbon emission reduction and sequestering projects within the borough.

Renewable Heat Incentive (RHI) and Clean Heat Grant Scheme

The domestic RHI has been extended to 31st March 2022 in the March 2020 budget – this provides a tariff over seven years which can cover the additional costs of installing a heat pump versus a gas boilers.

From 2022 the Clean Heat Grant scheme will come into effect. This is currently under consultation however is currently proposed to take the form of a £4,000 capital grant towards the cost of heat pump integration.

SEG – smart export guarantee

The smart export guarantee (SEG) is an obligation set by the government for licensed electricity suppliers to offer a tariff and make payment to small-scale low-carbon generators for electricity exported to the National Grid, providing certain criteria are met . SEG Licensees determine the rate they will pay, contract length and other terms.

The SEG is an opportunity for anyone who has installed small scale (<5MW) PV, wind, micro CHP, hydro and anaerobic digestion. This may encourage integration of PV with electrified heating systems – however the inclusion of thermal storage can help limit export from on-site PV generation, likely an increased financial incentive compared to export tariffs.

3.4 Revenue models

Heat as a Service (HaaS)

Heat as a Service (HaaS) is a new model for how heat is sold. Consumers choose how much to spend on the experience they want (e.g. warm hours) instead of paying for kilowatt hours of energy. To do this, customers can choose which rooms are heated to what temperatures and for how long through the 'warm hours' model. This can be easily done using a digital system.

Energy Systems Catapult (ESC) created a 'Living Lab' of 100 homes to test Heat as a Service during the Winter 2017/18 field trial. In the trial customers were offered the choice of three heat plans that vary depending on customer needs :

- Fixed
- FlexiTime
- Unlimited

A useful analogy to this is telecoms operators who sell bundles of texts, minutes and data at different prices. Using this model many customers now pay monthly for mobile phones rather than incurring large up-front costs. These packages also include warranties, services, repairs and upgrades to newer models.

Using this business model, low carbon energy can be sold as a package to suit customer needs - with prices for new equipment (such as heat pumps), servicing and upgrades wrapped up in one price. This could unlock:

- Accelerated uptake of low carbon heating: as there are reduced large up-front costs for new equipment and customers can be guaranteed their desired level of comfort for an agreed price. On the ESC trial 58% of triallists who had bought a Heat Plan were open to a low carbon alternative when replacing their gas boiler. This compares with around 33% of owner-occupiers in the general population.
- Improved consumer experience: the ESC trail showed customers found the idea of paying a fixed price for HaaS rather than for units of fuel easy to understand. The heat plans also improved their level of control of comfort levels.

Energiesprong

Energiesprong offer a whole house refurbishment to existing buildings as well as new building standard. To date the social housing sector has been the launching market in the UK for these solutions, with a view to later scale to the private homeowner market. The retrofit upgrades buildings to a level similar to Passive House standard and typically integrates a heat pump, hot water tank and PV to reduce carbon associated with heat. The on-site installation is designed to take around 2 weeks to minimise disruption to residents and therefore encourage uptake – much is prefabricated offsite.

The Energiesprong Promise:

- 21oC all year round
- 40 minutes of hot water and 180 litres per day
- Less than 2,300 kWh heat consumption per year with a thermal performance of less than 30 kWh/m2
- Live temperature, hot water and electricity consumption monitoring
- Less than 10 days installation time.

Energiesprong business model

The business model objective of Energiesprong is that tenants have the same monthly expenditure. Instead of tenants paying the gas/electricity utility provider they instead pay the housing association for an ‘energy service plan’ that guarantees a set conform level (similar to HaaS above). The cost of the energy service plan is derived from the alternative cost to the tenant when purchasing this conform level through a traditional utility provider.

This new income stream for the housing association can be used to pay for the initial retrofit costs of each property Capital costs for the systems are currently around £80k however Energiesprong hope to get this down to £45k in the future, following the market price reductions seen in Europe .

To change the market dynamic and drive down prices for this solution, initial scale of demand is essential. This is why Energiesprong are focussing on the social housing sector to begin with, as it is easier to organise sufficient demand with housing associations than in the private sector.

Once this demand threshold is reached, the private market business model can work much in the same way. A financer can provide an additional loan to homeowners to finance the refurbishment package. Then homeowner pays instalments on the loan, instead of paying energy bills. Performance guarantees are essential here so financiers know the energy bill will be reduced.

The financier providing the loan could be a mortgage provider or LBL could take on the funding and give homeowners access to low interest loans. Barriers to this include increased debt when coming to sell the property. However, it is possible the continuation of the loan could be included in the onward sale agreement.

Table 3.1: Cost comparison of Energiesprong model between housing association and tenant

	Upfront cost	Ongoing monthly costs	Income stream
Housing association	£££ - cost of fabric retrofit and low carbon technologies	£ - operations, maintenance and billing (this can be outsourced to a third party)	Revenues collected from tenant's energy service plans. This can be used to pay for initial retrofit costs. Possible funding revenues e.g. RHI, MEEF and ECO
Tenant	None	££ - monthly energy services plan (equal to the alternative cost from traditional gas/elec utility providers)	Avoided maintenance costs

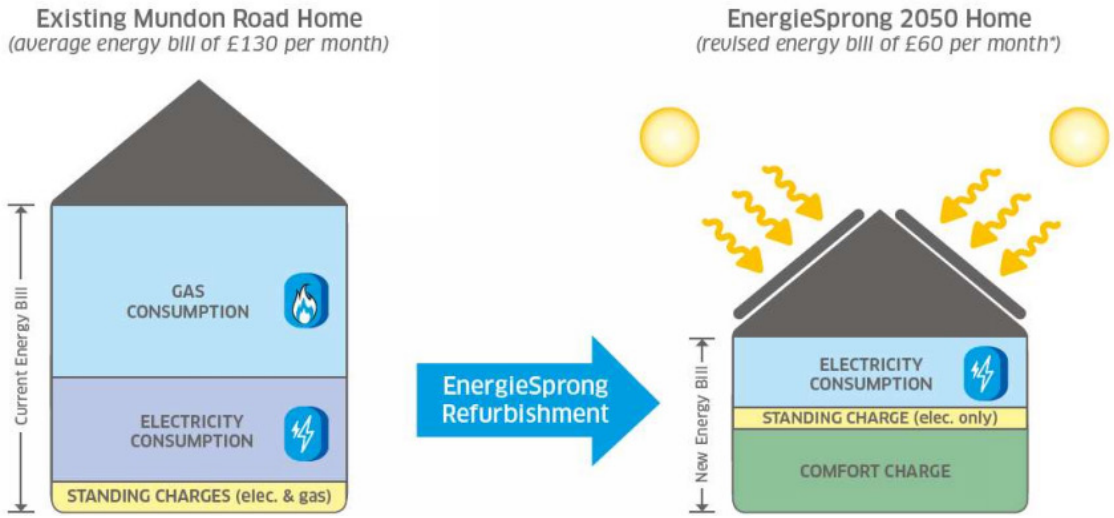


Figure 3.1: Before and after business model (top) and consumer costs (bottom) (Energiesprong)

Solar Together London (with Solarcentury)

Solar Together London is a group buying scheme that forms part of the Mayor of London's solar strategy . So far it has been implemented in 12 boroughs across the city. The scheme is being run in partnership with Solarcentury who won the auction to install the solar systems.

The scheme invites homeowners in the borough to express interest in installing solar. The homes are then grouped together and installers are invited to tender for the work. The scheme attracted interest from more than 3,500 homes in its first few months after the London launch in 2018. The solar systems were offered at an average discount of 35% on market rates .

Sign up is free and without obligation. As well as this it provides confidence to homeowners that they are getting a high-quality system at highly competitive prices, from trusted installers. This model could be replicated with heat pumps to increase uptake and ensure customer confidence.

Utility suppliers

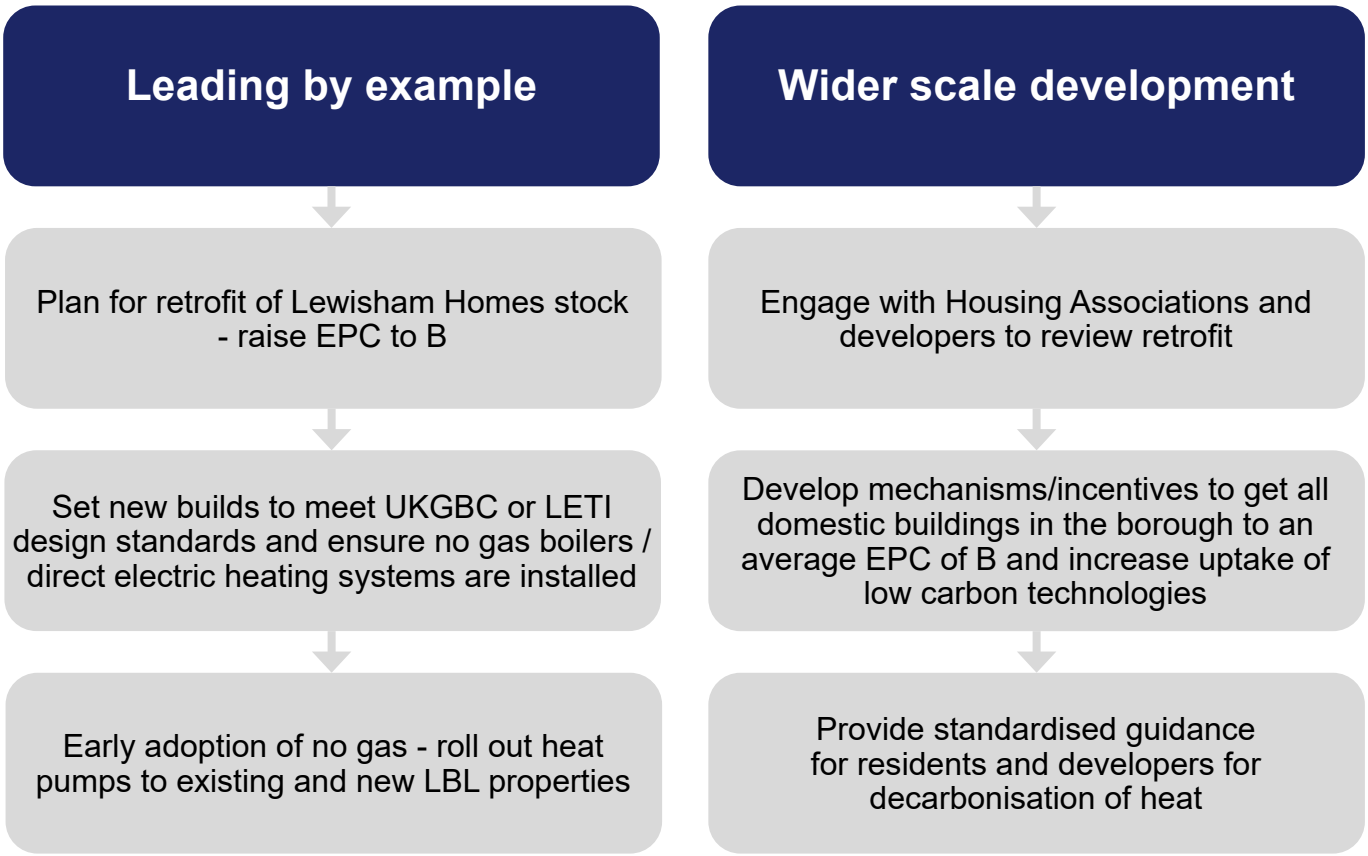
EdF are currently offering to install hybrid ASHPs to customers with oil or LPG heating at a massively reduced price. This integrates a heat pump with the existing oil or LPG boiler.

The business model is based on EdF receiving the RHI subsidy over the seven-year period as well as a 'monthly smart control fee' for these seven years . This is likely to save users money, provide additional resilience in their heat supply and take away some of the perceived risk from installation of heat pump technology.

3.5 Recommended steps

It is clear the scale of change in the housing market is extremely large to meet the aims set out in the Climate Emergency Action Plan. This level of intervention is unlikely to be achieved using traditional business models and without access to funding. However, as the case studies show, it is possible to deliver energy efficiency measures across all building types.

In many ways the 'lower hanging fruit' is Lewisham's own building stock alongside other social housing providers where the buildings are some of the worst performing, often similar architecture and less complex (e.g. within Lewisham's control and where no leaseholders). Lewisham should use these opportunities to lead by example thereby driving down cost and encouraging skills development in the area:



Appendix A Other relevant studies

BEIS Cost Optimal Domestic Electrification study (underway)

- The Department of BEIS has commissioned a detailed modelling study to help answer the question of what is the cost optimal combination of energy efficiency measures and low carbon electric heating technologies to decarbonise the energy used for heating in homes in England and Wales.
- This includes to develop a suite of dynamic building models representing the vast majority of different dwelling types in England and Wales. These will be used to answer the overarching question of determining the cost optimal combination of measures to decarbonise homes with electric heating technologies. These questions will include understanding the flexibility potential that the building as a system can provide to the electricity network. The outputs from this analysis will be used to scale up the findings from the dynamic models to the entire housing stock across the UK.

GLA Low Carbon Heat: Heat Pumps in London

Provides further information on heat pump integration in London

https://www.london.gov.uk/sites/default/files/low_carbon_heat_-_heat_pumps_in_london_.pdf

LETI Climate Emergency Design Guide

This guide outlines the requirements of new buildings to ensure climate change targets are met. It covers 5 key areas: operational energy, embodied carbon, the future of heat, demand response and data disclosure. Includes four key building archetypes (small scale residential, medium/large scale residential, commercial offices, and schools). The guide was developed by over 100 LETI volunteers (from the industry) over a period of 12 months.

LETI believes that by 2025, 100 percent of new buildings must be designed to deliver net zero carbon, and the whole construction industry will need to be equipped with the knowledge and skills necessary. https://www.leti.london/cedg

The Lewisham Climate Emergency Action Plan

Approved in March 2020, the Lewisham Climate Emergency Action Plan details the ambition for the borough to be carbon neutral by 2030. A full copy of the report can be found here: http://councilmeetings.lewisham.gov.uk/documents/s72555/Climate%20Emergency%20Action%20Plan.pdf

Lewisham & South East London domestic energy efficiency retrofit

Produced by Future Climate and the London Sustainability Exchange (March 2016)

Provides further information on the scale of retrofit measures required in Lewisham and several retrofit packages and persona types to describe and categorise each household.

BURO HAPPOLD

045175 Lewisham Energy Masterplan

STRATEGIC BOROUGH-WIDE DECARDINISATION

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