BUROHAPPOLD ENGINEERING

Borough Wide Heat Demand and Heat Source Mapping

London Borough of Camden

033382

15 May 2015

Revision 03

Revision	Description	Issued by	Date	Checked
00	Draft for Camden comments	CG	24.12.14	CC
01	Final for issue	CG	13.02.15	CC
02	Final incorporating HNDU comments	CG	15.04.15	BS
03	Final incorporating LBC comments	CC	15.05.15	CG

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Glossary

Term	Definition
BH	BuroHappold
CCCA	Camden Climate Change Alliance
CIP	Community Investment Programme
CO_2	Carbon dioxide
CHP	Combined heat and power
DECC	Department of Energy and Climate Change
DEPDU	Decentralised Energy Project Delivery Unit
DE	Decentralised Energy
DEN	Decentralised Energy Network
DH	District Heating
GIS	Geographic Information System
GLA	Greater London Authority
HNDU	Heat Network Delivery Unit
HS2	High Speed Two
LBC	London Borough of Camden
LLPG	Local Land and Property Gazetteer
MSOA	Middle Super Output Area
O&M	Operations and maintenance
TfL	Transport for London
VOA	Valuation Office Agency

1 Executive Summary

The London Borough of Camden (LBC) is targeting a Borough wide carbon reduction target of 40% by 2020 and 27% by 2017 (Camden Plan) and has identified decentralised energy (DE) as a key means of achieving this. This study refreshes and updates the 'Camden Large Scale CHP Pilot Site identification' study undertaken in 2007 and covers three key areas:

1. Update of Borough wide heat demand map
2. Determination of potential locations for secondary heat supply sources
3. Identification of key opportunity areas

Key building typologies with significant heating demands have been identified from a bottom up study of all buildings across the Borough. These anchor loads have been used to inform locations for new decentralised energy networks (DEN).

In addition to five existing heat network clusters, six cluster areas have been identified for further assessment. These are:

- Kilburn
- Kentish Town
- South Camden
- Camley Street
- Russell Square
- Great Ormond Street

The existing clusters include the Euston Road corridor (Euston Area Plan and Somers Town Energy proposals), King's Cross, Bloomsbury, Gower Street, and Gospel Oak. These existing cluster areas have previously been highlighted as having high heat demand densities and potential for DEN and have previously been identified as part of the previous SEA 2007 heat mapping study and the GLA's Decentralised Energy Programme Delivery Unit (DEPDU) studies. Cluster assessments in this report focus on the six cluster areas that have yet to be progressed. All clusters are highlighted in Figure 1—1 overleaf.

Existing and under construction decentralised energy networks

Key decentralised energy networks existing or under construction in the Borough are:

- Gospel Oak, supplying heat from the Royal Free Hospital to LBC owned housing estates
- Gower Street, supplying heat from a CHP engine to University College London buildings
- Bloomsbury, supplying heat from a CHP engine to a number of colleges including Birkbeck and SOAS
- King's Cross, supplying heat from two CHP engines to the new Kings Cross mixed use development
- Somers Town, supplying heat to four estates with the future option of exporting power to the Francis Crick Institute.

Expansion of existing heat networks presents a significant opportunity for the Borough.

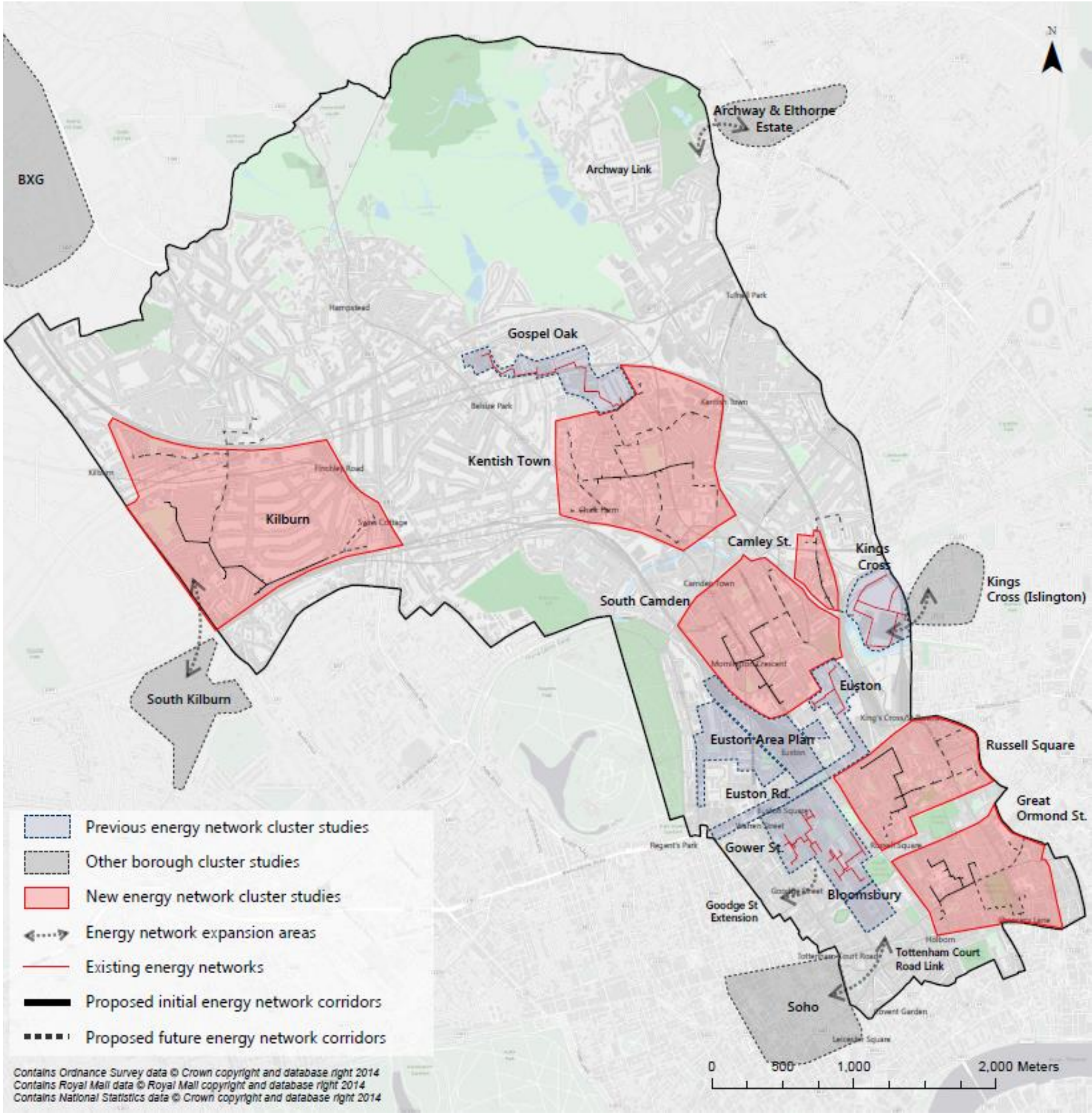


Figure 1—1 Borough wide DEN cluster identification

Heat demand mapping

Heat demands across the Borough have been grouped into tiers and mapped according to location. The demand tiers are applied to prioritise buildings which are most viable to connect to a DEN. Tier 1 includes key 'anchor loads' consisting of large public sector single occupant buildings with a known centralised heating supply and very large private single occupant buildings. Tier 2 includes large single occupant buildings where the heating system is unknown and may require significant conversion works for DEN connection. Tier 3 includes single occupant buildings with lower heating demands, or large multiple occupant loads. The heat demand assessment of this study has focused on tier 1 and tier 2. Tier 3 loads have not been included in the cluster studies but are recorded in the appendices of this report.

In total 468 GWh/yr. of tier 1 demands have been mapped. This represents approximately 24% of the estimated total heat demand of the Borough[1]. Including tier 2 and 3 demands this increases to 772 GWh/yr., approximately 40% of the total demand of the Borough. Clusters have been developed around these heat demands, with the fully developed clusters representing 133 GWh/yr. of heat demand, or 7% of the estimated total heat demand of the Borough. Supplying these clusters with district heat generated from highly efficient CHP gas engines and boilers would give a saving of 9,700tCO_2/yr.

Secondary heat supply

Six key sources of waste 'secondary' heat have been identified across the Borough as having potential as future low carbon heat sources to supply DEN. The total mapped resource for secondary heat supply across the Borough is 271 GWh/yr., 14% of the estimated total heat demand of the Borough and 58% of the tier 1 heat demands identified.

Secondary heat is typically available at a low grade and requires the use of heat pumps to raise the temperature to match the heat demands of conventional building heating systems. As a balance between heat source and heat supply temperatures an average supply temperature of 70°C has been assumed, which would require an additional 105 GWh/yr. of heat pump electricity in order to raise the temperature of the low grade heat sources to deliver 376 GWh/year of heat to decentralised energy networks. The low carbon credentials of secondary heat are reliant on the decarbonisation of the electricity grid, as all sources identified require an uplift using heat pumps to meet conventional demands.

Only a proportion of this secondary heat is expected to be technically and commercially viable and hence a restricted heat supply has been considered in the DEN cluster studies to capture the most viable of these sources. Based on a shortlist of sources, electricity substation transformers and ventilation shafts have been identified for further assessment. Of most interest for secondary heat supply is the Great Ormond Street cluster. This cluster has the opportunity to connect to two UKPN substations, providing 7,600 MWh/yr. of heat, 15% of the initial heat network demand.

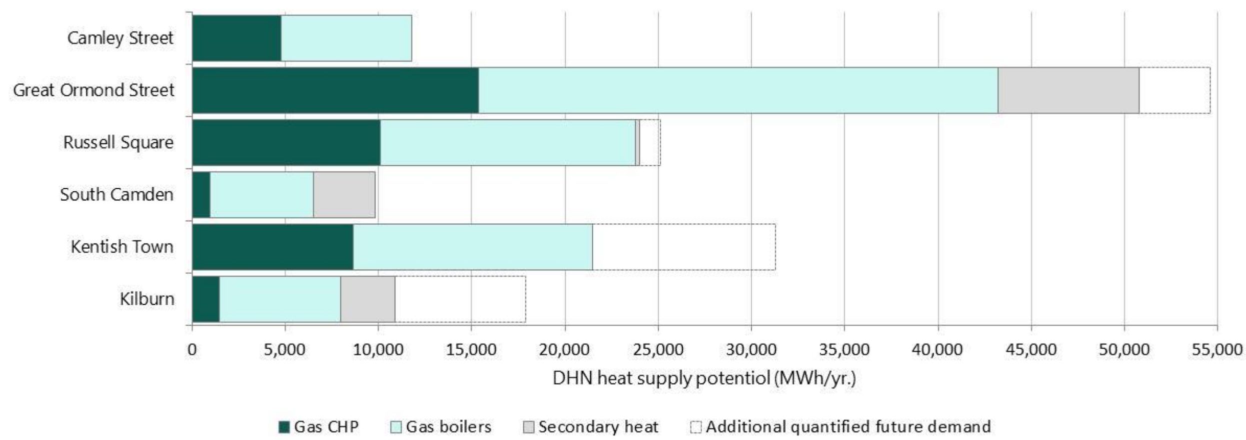


Figure 1—2 Heat supply for secondary heat scenario

Identified new heat demand clusters

Kilburn

[1] Based on DECC sub-national energy statistics and 0.8 fuel to heat conversion factor.

The Kilburn cluster centres around the Kingsgate Road, Casterbridge and Snowman estates, and new proposed residential developments along Abbey Road. The cluster is located between the Thameslink railway line to the north and the overground line to the south, with the future northern extension to the scheme requiring connection over the northern rail link but providing opportunity in the form of new developments which can be future proofed for network connection.

The following recommendations are set out as key objectives to determine the viability of this network:

- Consultation with Kingsgate Primary school to understand their current heating system and interest in DEN
- Determination of timeframe of Abbey Road redevelopments and potential for DEN future proofing
- Detailed constraints assessment to validate pipe routes and crossing of railway lines
- Consultation with UKPN to understand proposals for Lithos Road substation and potential for heat recovery
- Detailed feasibility study of cluster loads including a detailed techno-economic assessment.

Kentish Town

The Kentish Town cluster is centred around the St Silas estate, Kentish Town sports centre, Haverstock Secondary School, Denton estate, and Harmood Street estate, with a strong linear heat demand density running along Prince of Wales Road. There are various potential extensions to the north, south, east and west, with the northern extension offering a potential connection to the existing Gospel Oak heat network. The cluster is mainly existing buildings, with three CIP schemes included as potential future network extensions.

The following recommendations are set out as key objectives to determine the viability of this network:

- Consultation with Haverstock Secondary school to understand their current heating system and interest in DEN
- Determination of timeframe of CIP schemes and potential for DEN future proofing of new developments, in relation to future extensions,
- Detailed feasibility study of cluster loads including a detailed techno-economic assessment.

South Camden

The South Camden cluster is the smallest of the clusters considered in this study, connecting the Curnock Street Estate in the centre of the Borough to other surrounding LBC estates and Greater London House. As a standalone scheme the benefits of this cluster are limited however, the site is a strategic link between the Somers Town Energy network and new developments along Royal College Street and St Pancras Way. Connection to either of these developments would strengthen the case for a DEN in this area, increasing the number of large anchor loads of the scheme. The scheme also has the potential to connect to the St Pancras substation, the largest in the Borough and a possible secondary heat source.

The following recommendations are set out as key objectives to determine the viability of this network:

- Consultation with Greater London House to understand heating systems and interest in DEN
- Detailed feasibility study of cluster loads including techno-economic assessment comparing the scheme as a standalone DEN and connecting to the Somers Town Energy network and the Royal College Street site allocations and substation
- Detailed constraints assessment to validate pipe routes and cost of crossing Camden High Street (may prohibit connection to Greater London House and Arlington Road demands)

- Consultation with UKPN to understand the renovation works at the St Pancras substation and the potential for heat recovery.

Camley Street

Should the Camley Street corridor sites be developed this cluster presents a good technical opportunity for a decentralised energy network, given the density and mixed use nature of the area. Furthermore the timescale for development sites are such that there is the opportunity to drive the building designs through planning obligations so that they are compatible for connection to a future network. The viability of the scheme is reliant on the development of new sites as existing sites in the area are less suited to connection. Although central to the Borough, the Camley Street cluster is limited in expansion potential because of the physical constraints of the canal and rail track bounding the east and west of the site.

Russell Square

Russell Square as a standalone DEN cluster has appeal as the majority of anchor loads are owned by LBC. Notwithstanding these loads, inclusion of a large single site is preferential to house the scheme energy centre and act as a catalyst for the network development. The Brunswick centre could provide this load, once the existing heating plant is up for renewal. Further work is required to understand this site and the future opportunities. Alternatively, an extension to the existing Bloomsbury network could be possible. Although there are no immediate plans to expand in this area this extension has been investigated previously and could link into new university accommodation being planned in the south west of the cluster.

Great Ormond Street

The Great Ormond Street Cluster presents a good opportunity for the integration of the hospital, two large secondary heat sources (UKPN substations) and adjacent LBC estates to establish a future DEN.

The viability of the scheme is reliant on developing a business case to connect the hospital as the key catalyst of the network. The hospital has an existing onsite CHP led network and so two options exist for developing a new heat network, either the current scheme is extended with the capacity to serve external loads or the hospital is connected to a new off-site energy centre. The Gospel Oak Community Heating scheme provides precedent for a hospital exporting heat to LBC housing.

Consultation with the Great Ormond Street Foundation Trust is a priority for this cluster to understand the future energy and carbon drivers of the hospital. Following this a more detailed techno-economic model should be developed to inform a commercial options study looking at ownership options for a future network. This should consider a scheme owned and operated by the hospital, council or third party ESCo as well as a combination of these stakeholders.

Techno-economic modelling

For each cluster building a reference heating and electricity profile has been assigned and used to indicatively size cluster energy centres, assuming heat demands are met by a combination of natural gas fired CHP engines and gas boilers. The addition of secondary heat in each case is noted for the expansion of clusters but is not considered a key driver for establishing a cluster. It has therefore been excluded from the initial cluster techno-economic assessments. A simplified economic model has been developed to compare the financial performance of each cluster. The costs and revenues of each are those which would typically be associated with a third party developer and do not consider costs beyond the primary network extent such as building conversion works. A summary of the key techno-economic outputs for these clusters is given in Table 1—1.

Table 1—1 Summary of cluster techno-economic modelling results

Cluster	Heat demand (MWh/year)	Trunk network length (m)	CHP capacity (kWth)	Total capital cost (£)	IRR for 25 year scheme (%)
Kilburn	10,900	1,600	700	£4,013,000	2%
Kentish Town	21,500	700	1,400	£3,663,000	12%
South Camden	14,100	900	700	£2,698,000	6%
Russell Square	24,000	1,200	1,700	£5,157,000	9%
Great Ormond St.	50,800	1,000	3,800	£7,370,000	15%
Camley St	11,800	800	800	£2,556,000	9%

Cluster prioritisation

A cluster prioritisation exercise has been undertaken based on a number of weighted criteria including IRR, carbon savings, space constraints and regeneration potential. This exercise has been carried out using two different weighting scenarios, one assuming heat network delivery is led by LBC and one where delivery is led according to investment criteria. The prioritisation exercise demonstrates that Great Ormond Street and Kentish Town are consistently high performing clusters, subject to more detailed studies concerning commercial viability, as both of these clusters have a number of key risks associated with connection to large existing institutions. Defining this commercial and buildability risk is key to understanding cluster prioritisation in more detail. From a technical and economic standpoint all clusters show potential as viable schemes.

Next steps

Prior to completion of this study, LBC planned to take forward three clusters for further detailed analysis, these are:

- Kentish Town West - techno-economic options appraisal based on a suite of area background data
- Somers Town Energy network - techno-economic appraisal of extending the current scheme to include future heat demands
- Bloomsbury area - master-planning exercise on the area surrounding the existing energy networks.

This study has reconfirmed the suitability of these three clusters. It is recommended that alongside the techno-economic and masterplanning works proposed for these clusters, stakeholder engagement and review of DEN delivery models is undertaken. For other clusters identified as suitable through this study, where not picked up in the above studies, further analysis should be carried out led by stakeholder engagement to understand better the commercial barriers to network development and the development of more detailed techno-economic assessments.

2 Introduction

2.1 Context

BuroHappold Engineering Ltd (BH) has been commissioned by the London Borough of Camden (LBC) to carry out a decentralised energy study as part of DECC's Heat Network Development Unit (HNDU) funding scheme aimed at developing new and expanding existing decentralised energy networks.

LBC are targeting a 40% Borough wide carbon reduction target by 2020[2] including a 27% reduction by 2017. They have identified decentralised energy as a key means of achieving this. This study refreshes and updates the 'Camden Large Scale CHP Pilot Site identification' study undertaken in 2007 and will provide strong linkages to a number of existing and planned development and policy areas. In addition the outputs of the study will be used as part of the Council's application for further HNDU funding to develop heat network designs for highlighted opportunity areas.

District Heating (DH) provides heating and hot water via a below ground hot water pipe network from a single energy centre. This improves the efficiency of heat supply, typically providing lower carbon and lower cost heating and hot water, whilst removing the need for building based heating plant. Decentralised Energy (DE) refers to energy (commonly electricity) produced close to where it will be used, rather than at a large plant elsewhere and sent through the national grid. Local generation of electricity reduces transmission losses and lowers carbon emissions. Security of supply is increased nationally as customers don't have to share a supply or rely on relatively few, large and remote power stations. DE and DH come hand in hand through use of Combined Heat and Power (CHP) engines which generate heat and electricity locally, and supply heat to buildings via a decentralised energy network (DEN).

2.1.1 Scope

This project targets three key areas relating to decentralised energy network development across the LBC:

1. Update of Borough wide heat demand map: current and projected mapping of domestic and non-domestic heat demands to refresh the SEA reports to include engagement with Camden Council and relevant third party developers to ensure that consented major applications since 2007 and up to date communally heated council estate data are included.
2. Determination of potential locations for secondary heat supply sources: desktop Borough wide study of secondary heat sources in Camden. Where secondary heat sources are found in areas identified under the heat mapping exercise as having potential for DEN growth, to more fully investigate the viability of each secondary heat source in that location from a technical and economic perspective including the likely grade of heat and viability of heat as a source for a DEN.
3. Identification of key opportunity areas: taking into account the above heat demand and supply mapping, identify, prioritise and recommend opportunity areas in the Borough with potential for DEN development and provide a clear route-map and strategic vision for how the identified opportunities should be taken forward.

This study is limited to the high level appraisal of DEN opportunities. Identified clusters should be subject to a subsequent detailed techno-economic analysis to validate assumptions on energy demands, physical and commercial constraints and project finances.

[2] Against a 2005 baseline

2.1.2 Existing decentralised energy networks

There are a number of existing decentralised energy networks located within the London Borough of Camden. These are reviewed below.

Gospel Oak: Completed in 2013, the Gospel Oak project now supplies circa. 1.5MW of surplus heat from a new CHP engine within the Royal Free Hospital to 1,449 dwellings across six LBC owned housing estates, via approx. 1km of network length. This meets approximately 50% of the residential heat demands, with the remaining 50% met by high efficiency communal boilers. The Royal Free Hospital CHP engine provides electricity and steam for the hospital; an economiser was retrofitted onto the existing engine to enable heat take off. The scheme saves an estimated 2,800 tonnes of CO_2 per year. The agreement between the Royal Free Hospital and LBC is for 14 years, after this the contract will be reassessed. Further heat may be available from the hospital. This cluster was identified in the 2007 SEA study for LBC on Large Scale CHP Pilot Site Identification.

Gower Street: The Gower Street Heat & Power decentralised energy network serves the main University College London (UCL) Bloomsbury Campus as well as a number of University College London Hospital (UCLH) buildings adding to the thermal base load. Heat is provided from a combination of CHP and conventional boiler plant. The Gower street network contains a 3MWe CHP engine, with potential for an additional 1.5MWe generation capacity. Heat and power are supplied under long-term Public Private Partnership (PPP) contracts.

Bloomsbury Heat and Power Network: The Bloomsbury Heat and Power Network is located just south of the Gower Street Network, between Gower Street and Russell Square. The network is served by 4.5 MWe of gas fired CHP plant. The network serves a number of colleges of the University of London including Birkbeck and SOAS. The network is operated by Cofely District Energy, and heat and power are supplied under long-term Public Private Partnership (PPP) contracts.

King's Cross Network: The decentralised energy network in King's Cross was planned in 2005 as part of site-wide regeneration works led by the developer Argent. The development contains 25 new office buildings, 10 new major public buildings, the restoration and refurbishment of 20 historic buildings and structures and up to 2,000 homes and serviced apartments. The decentralised energy scheme is being operated by Metropolitan and is targeting a 50% reduction in CO_2 emissions. At full build out, it is intended that the energy centre will provide almost 100% of heat and hot water needs and 80% of electricity demand.

The main energy centre at King's Cross will comprise three 2MWe CHP engines and three 10MW gas-fired boilers to provide heating, hot water and locally generated electricity to the development. It is being constructed in phases in line with development programme. The energy centre has been operational since 2012 and currently contains two CHP engines with the third planned for future installation.

2.1.3 LBC current heat network construction

Somers Town Energy: The Somers Town Energy network was identified as a cluster in the 2007 SEA study for LBC on Large Scale CHP Pilot Site Identification. The scheme is currently in construction and will consist of two phases. The first phase will centralise the heating systems of 339 dwellings spread across four estates within an energy centre to be retrofitted into an existing basement car park. The second phase is anticipated to see the installation of a CHP engine to also provide electricity to a newly built commercial development, the Francis Crick Institute.

2.2 Previous relevant heat mapping studies

2.2.1 Delivering a Low Carbon Camden

This report (2007) provides a broad vision of how energy and transport provision across Camden might look in 2050, given a number of scenarios considering the energy generation mix required to meet CO_2 emission reductions of 60-90%. The resulting scenarios included high penetrations of CHP in the future generation mix. As such, this study was used to inform the subsequent Large Scale CHP Pilot Site Identification report.

2.2.2 Camden Large Scale CHP Pilot Site Identification report

SEA/RENUE were commissioned in 2007 to assist LBC with the identification of pilot sites for a large scale CHP installation. The approach taken was to map LBC estates with community heating, corporate stock and other potential customers such as hospitals and housing associations and estimate heat and electricity demands. These were then grouped into 20 separate clusters.

From these clusters three schemes were shortlisted as having the greatest potential for decentralised energy deployment, these were:

- Cluster 3: Gospel Oak
- Cluster 5: Kentish Town West
- Cluster 9: Euston

A more detailed analysis was carried out for each of these clusters, establishing a provisional network to interconnect the buildings as well as sizing and costing heat network infrastructure, used for a high level financial analysis.

Kentish Town West is the only scheme of the three yet to be progressed. LBC is now seeking to expand their decentralised energy programme by developing this cluster. This study will consider this aspiration, alongside a refreshing of the 2007 Borough wide heat map and building an evidence base for established networks to be supported by secondary heat sources.

2.2.3 London Heat Map

The London heat map is an interactive online tool created as part of the Decentralised Energy for London programme and compiles heat demand data collected across all London Boroughs for 16 priority building types. The map is populated with individual building data as well as a raster overlay based on benchmarked predications for the heating demand of all buildings (irrespective of connection viability). It collates information gathered as part of the Camden Large Scale CHP Pilot Site Identification study and other city wide studies. An extract of this heat density raster shown in Figure 2—1 below and serves to highlight Camden as a Borough with one of the highest heat demand densities of the capital.

Data stored in the London heat map is now out of date. This study will update demand, supply network and opportunity area information, with results categorised for compatibility so that data from this study can be embedded in the map for future heat mapping exercises.

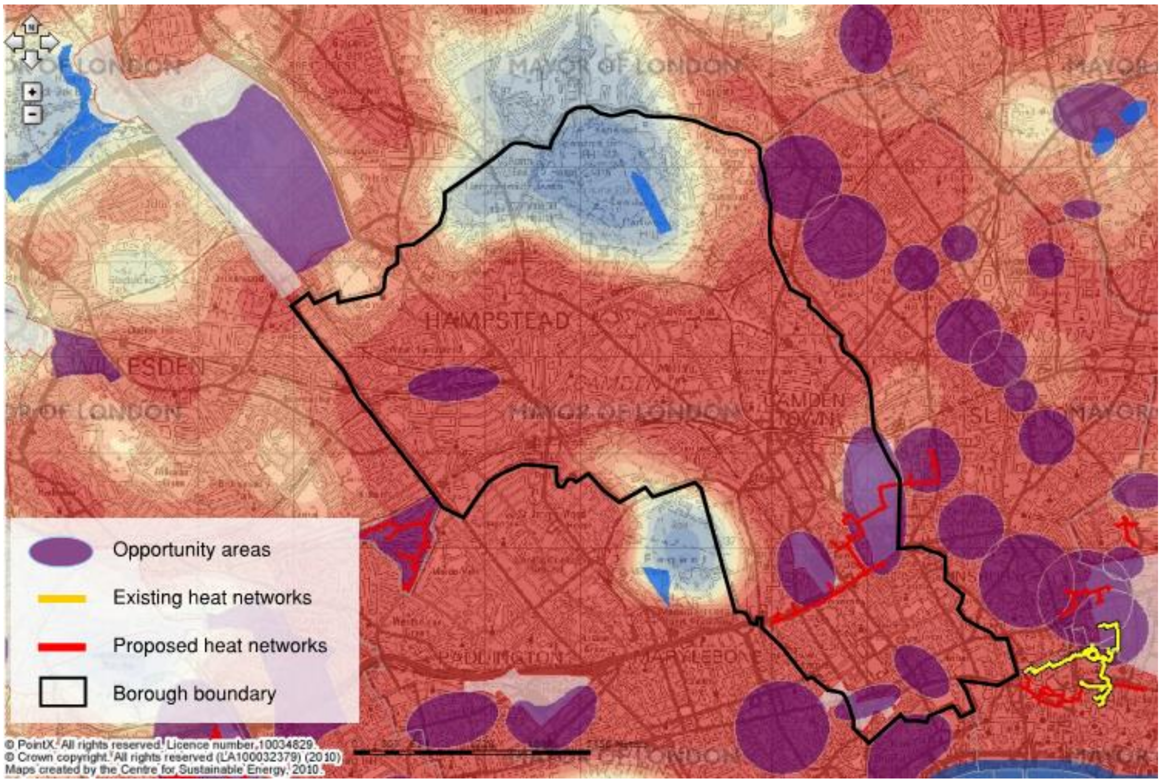


Figure 2—1 London Heat Map extract (out of date)

2.2.4 Decentralised Energy Project Delivery Unit (DEPDU) feasibility studies

LBC has also previously received feasibility support from the Mayors DEPDU funding programme. This support has mainly focussed on the Bloomsbury and Euston areas.

The Bloomsbury study considers expanding the Bloomsbury area networks (Figure 2—2) to the British Museum and Great Ormond Street Hospital (GOSH), as well as the potential to connect the existing Gower Street and Bloomsbury networks. A separate study has also been undertaken looking at the potential to connect GOSH to the Tybalds housing estate, separate from the wider Bloomsbury network.

The Euston study focuses on the area around Euston station which is to be redeveloped as part of the programme of proposed works for HS2. The study found that a decentralised energy network in this area can deliver a positive NPV and recommends that network build out is timed to coincide with station redevelopment works. The extent of the proposed network is shown in Figure 2—3. This report has been used to inform planning policy in the shape of the Euston Area Plan (EAP).

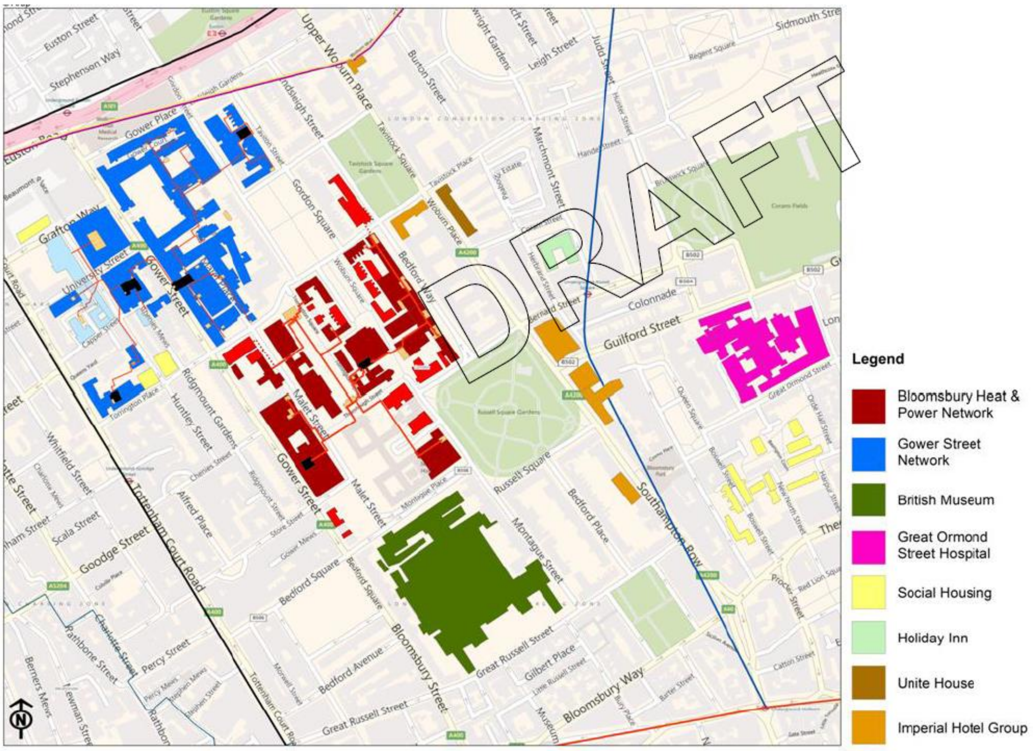


Figure 2—2 Bloomsbury area proposed scheme

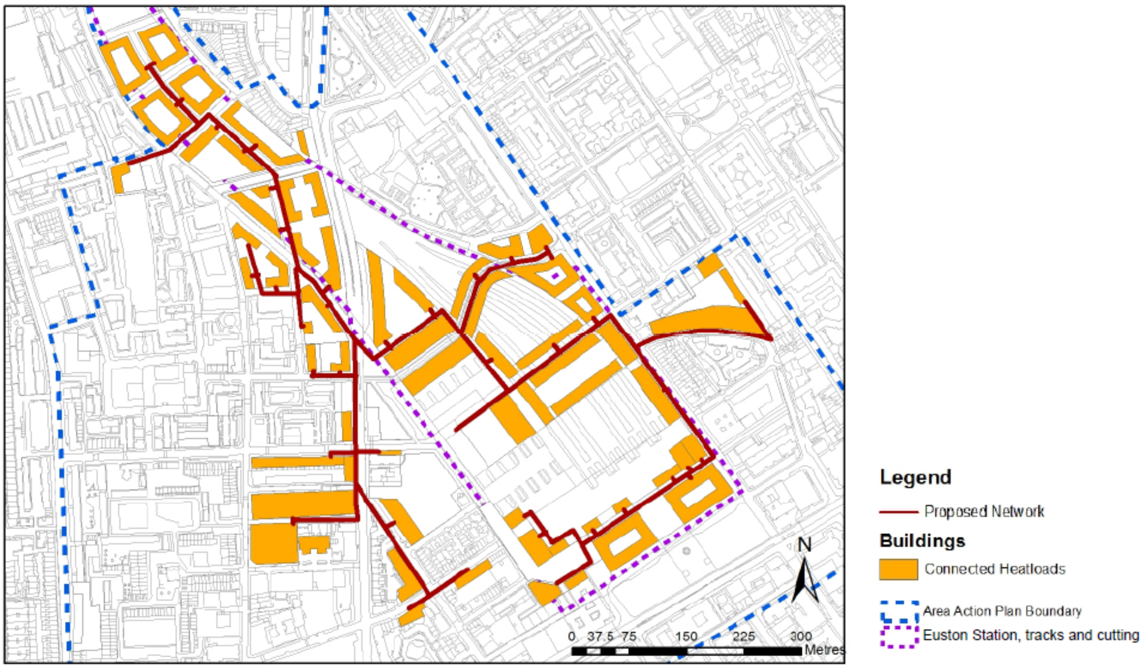
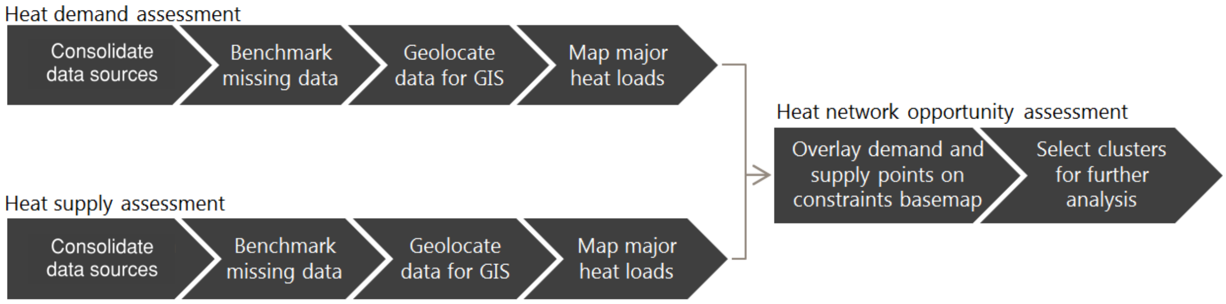


Figure 2—3 Euston area proposed scheme

3 Methodology

The methodology for this study is split into three areas of assessment which align with the three study areas given in section 2.1: heat demand, heat supply and network opportunity identification. These assessments follow the process flow diagram below.



All maps used in this study have been developed in GIS software using the OS VectorMap District Open Data as a basemap. This basemap data has also been used to add natural constraints to the maps (river, rail, road, water, and infrastructure), as shown in section 4. Existing network maps have been added to the basemap based on as built drawings provided by LBC.

3.1 Anchor loads and demand tiers

The selection of areas to develop heat networks is dependant not only on the magnitude of heat demands but also the suitability of connecting a new network to existing building heating systems. Understanding existing buildings is crucial to developing opportunity areas as they can be anchor loads which act as catalysts for decentralised energy network deployment. The following attributes are preferable for selecting priority 'anchor load' buildings;

- Communal heating systems: *reduced cost of heating system retrofit*
- LBC assets/ other large single ownership: *greater control over development portfolio*
- Large privately owned buildings: *size of demand, ease of connection, cost of connection*
- Future developments: *opportunities to mandate connection to decentralised energy networks*

A methodology for selecting data to map has been developed based on a demand 'tier' system. Tiers are based on prioritising loads most likely to connect to a DEN. Three tiers have been allocated as such.

Table 3—1 Data tiers for building prioritisation

Tier	Rationale
Tier 1	Key anchor loads. Large single occupant buildings with large heating demands with known centralised heating supply. Mix of LBC and private assets (see Table 3—2).
Tier 2	Expansion loads. Medium heating demands. Large single occupant, heating supply unknown
Tier 3	Unknown loads. Medium or low heating demands. Split of occupants and heating systems unknown

A matrix showing the split of data amongst these tiers is set out in Table 3—2 below. Caps on annual heat demand are notional and have been set to reduce the number of buildings considered per network to those of greatest interest. LBC owned assets and future developments have lower heat demand caps to reflect that connection viability is a balance between both practical, commercial and demand constraints, where the commercial and practical constraints are less (LBC have influence over their own assets and future developments), a lower demand may be viable for connection. Where privately owned assets are identified for connection, their demand must be high to merit the commercial arrangements and variation from the business-as-usual case for a third part developer.

These demand bands have been set based on past experience and correspondence with LBC. Data inputs for each of the building categories below are set out in the following sections.

Table 3—2 Demand tiers by building typology

		Annual heat demand (MWh/yr.)					
Building Category	Building Typology	0-100	100-500	500-1000	1000-2000	2000-5000	5000+
LBC owned	Communally heated housing	tier 3	tier 2	tier 1	tier 1	tier 1	tier 1
LBC owned	Education	tier 3	tier 2	tier 1	tier 1	tier 1	tier 1
LBC owned	Leisure	tier 3	tier 2	tier 1	tier 1	tier 1	tier 1
LBC owned	Corporate assets	tier 3	tier 2	tier 1	tier 1	tier 1	tier 1
Large private	Other	tier 3	tier 3	tier 2	tier 1	tier 1	tier 1
CCCA	Offices	tier 3	tier 3	tier 2	tier 1	tier 1	tier 1
CCCA	Arts	tier 3	tier 3	tier 2	tier 1	tier 1	tier 1
CCCA	Hotels	tier 3	tier 3	tier 2	tier 1	tier 1	tier 1
CCCA	Education	tier 3	tier 3	tier 2	tier 1	tier 1	tier 1
CCCA	Health	tier 3	tier 3	tier 2	tier 1	tier 1	tier 1
CCCA	Community	tier 3	tier 3	tier 2	tier 1	tier 1	tier 1
Other large private	Offices	tier 3	tier 3	tier 2	tier 1	tier 1	tier 1
Other large private	Retail	tier 3	tier 3	tier 2	tier 1	tier 1	tier 1
Other large private	Health	tier 3	tier 3	tier 2	tier 1	tier 1	tier 1
Other large private	Workshop	tier 3	tier 3	tier 2	tier 1	tier 1	tier 1
Other large private	Other	tier 3	tier 3	tier 2	tier 1	tier 1	tier 1
Private domestic	All multi-address buildings	tier 3	tier 3	tier 2	tier 2	tier 2	tier 2
Planned sites	Non-residential	tier 3	tier 1	tier 1	tier 1	tier 1	tier 1
Planned sites	Residential	tier 3	tier 1	tier 1	tier 1	tier 1	tier 1
Planned sites	Community Investment Programme	tier 3	tier 1	tier 1	tier 1	tier 1	tier 1

3.2 Heat demand datasets

3.2.1 LBC owned buildings

Annual gas data records are available for all significant LBC buildings including education, housing, leisure, social services and local government buildings. Data for the period 2011-2014 has been assessed, taking the most recent year of reliable data in each case. For comparison with other datasets where demands are given for heat rather than gas, a gross fuel to heat ratio of 0.8 has been assumed to account for the gross efficiency of gas boiler systems.

3.2.2 Camden Climate Change Alliance

Camden Climate Change Alliance (CCCA) was formed by Camden Council in 2008 to support organisations in Camden that are committed to reducing CO_2 emissions and associated energy bills. The Alliance now has over 300 members who represent around 30% of Camden's non-domestic emissions.

Camden Council collect bulk gas demand data from organisations in the CCCA. By virtue of their membership it is assumed that Alliance members will be more interested in connecting to future DH projects than other private buildings. In collecting gas data the CCCA database is also a more reliable dataset than the VOA database for non-domestic buildings (see section 3.2.4).

3.2.3 Future planning sites

Three separate databases have been used to fully capture the extent of the proposed developments across the Borough. Where duplicate developments arise between the three databases these have been removed manually by spatially matching properties in GIS.

Planning Portal

The planning portal provides a database of projects that have been approved for planning but not yet constructed as of 31 March 2013. Those constructed prior to this data are captured in the VOA and LLPG databases discussed below. For each site the number of new residential units is provided alongside non-residential floorspace split by building typology. Heating demand benchmarks for each of these typologies have been applied to this data to generate an annual heat demand for each building. Benchmarks for this conversion are given in Appendix B.

Community Investment Programme (CIP)

The Community Investment Programme is a 15 year plan to invest money in schools, homes and community facilities across the Borough. The programme involves the redevelopment of properties that are out of date, expensive to maintain, or underused and difficult to access.

Where conversion works include the development of new dwellings and community space these have been benchmarked as with the planning portal buildings and added to the demand database.

Site allocations

LBC's proposed site allocations are given in The Site Allocations Development Plan Document and set out the Council's proposals for land and buildings on significant sites which are likely to be subject to development proposals during the lifetime of the Local Development Framework (2010-2025). These allocations are intended to assist in delivering the priorities and objectives of the Council's Core Strategy and the London Plan.

A description of proposed uses for each site allocation are included in this document however at a Borough level it is not possible to extract significant information to benchmark building energy demands from. Site allocations have been alluded to graphically in the maps in section 5 and 7 and included in heating clusters where co-located with other significant heat demands. The likelihood of each site coming forward is currently unknown and should be investigated in more detail where coincident with heat network clusters.

3.2.4 Private non-domestic buildings

Private non-domestic buildings not included in the LBC and CCCA databases have been mapped using floor area data for all sites registered under the Valuation Office Agency for tax reasons. This captures all significant business uses across the Borough. This database does not indicate the nature of heating systems for each building and so data has been aggregated for all floor areas with matching parent identification numbers, signifying single owner occupancy. This filtering process removes small businesses with minimal heating demands that would not be of interest for connection to a DH network. Heating demands have been derived using the benchmarks in Appendix B.

3.2.5 Private domestic buildings

The heat demand of all private domestic buildings has been mapped using the Local Land and Property Gazetteer (LLPG). This database captures the address of every building in the Borough. By grouping addresses under single parent identification numbers, the number of apartments in each development can be summed. Benchmark heat demands per flat can then be applied. This method is crude in some aspects as the benchmarks for single building demands do not take into account the scale of the buildings, however the buildings of most interest to DH are developments with many occupants, and as such an apartment benchmark have been used to derive heat demands.

To improve the heating demand data derived from the LLPG statistics for the average gas consumption per MSOA (census area) have been used to adjust as a top down method of adjusting the heating benchmark used to an average of 13,600kWh per address annually.

3.3 Heat supply datasets

Primary heat supply includes the provision of heat from existing and new major heating plant and existing networks. For the purposes of this study it is assumed that the existing plants and heating infrastructure in the Borough are sized to meet the demands associated with them and as such there is no large quantum of spare primary heat supply. The primary heat supply in each case is therefore assumed as a mix of centralised gas CHP and gas boilers provided from a single energy centre central to the scheme.

It is possible to recover 'waste' heat as a by-product of environmental process and infrastructure sources. This 'secondary heat' is discussed in more detail in section 6 of this report, with details of the process and quantum of heat available set out in section 6.

Data for the mapping secondary heat supply across the Borough has been taken from data used as part of the GLA's Secondary Heat Study[3] - key datasets which have informed this study are set out in Table 3—3. Not all sources listed were found to be present in Camden.

[3] London's Zero Carbon Energy Resource: Secondary Heat. *GLA, 2013*

Table 3—3 Data Inputs for secondary heat supply mapping

Secondary Heat Source	Dataset	Use In Model
Major power generating plat	Renewable Energy Foundation REGO London Heat Map DECC Digest of UK energy statistic	Location and predicted secondary heat supply
Industrial sources	London Atmospheric Emissions Inventory (LAEI)	Location and predicted secondary heat supply from major Industrial processes
Underground ventilation shafts	TFL Ventilation Shafts	Approximate location of TFL ventilation shafts and platform temperatures, interpolated for vent shaft temperatures. Known locations of HS2 vent shafts added (source: LBC), heat recovery characteristics applied from TFL trends.
Non HVAC - data centres	www.datacentermap.com	Location and recoverable heat for known commercial data centres
Non HVAC – supermarkets	Point of interest (POI) location data	Location and recoverable heat for major supermarkets
Sewer heat mining	Thames Water Trunk Sewer Map	Polyline in GIS modelling to highlight areas for potential heat abstraction
Rivers and canals	Environment Agency Rivers and Canals	Polyline in GIS modelling to highlight areas for potential heat abstraction
Building cooling system heat rejection	VOA commercial floorspace database	Building cooling system heat rejection for non-domestic developments > 10,000 m^2
Ground source	LBC land ownership map and OS Open data	Ground source potential restricted to certain areas for potential development

3.4 Gap analysis and data quality

The methodology use to map data has been based on the best available data. Where known buildings are missing from the available dataset, a gap analysis has been carried out using data available from one of the following sources:

- LBC: known gas demand or floor area for individual buildings
- London Heat map: historic heat mapping data from previous DEPDU studies

In addition to the anchor load LBC demand databases, data for registered social landlords (RSLs) was also sought. Quantitative information on these properties was not available for all sites across the Borough and so this has not been included in the assessment. This and other large residential private developments represent the largest gap in data. Where coincident with identified clusters, these should be investigated as part of tier 2 and 3 loads in future cluster studies.

4 Physical Constraints

Figure 4—1 highlights some of the key physical constraints to developing decentralised energy networks across Camden. These are discussed in more detail overleaf.

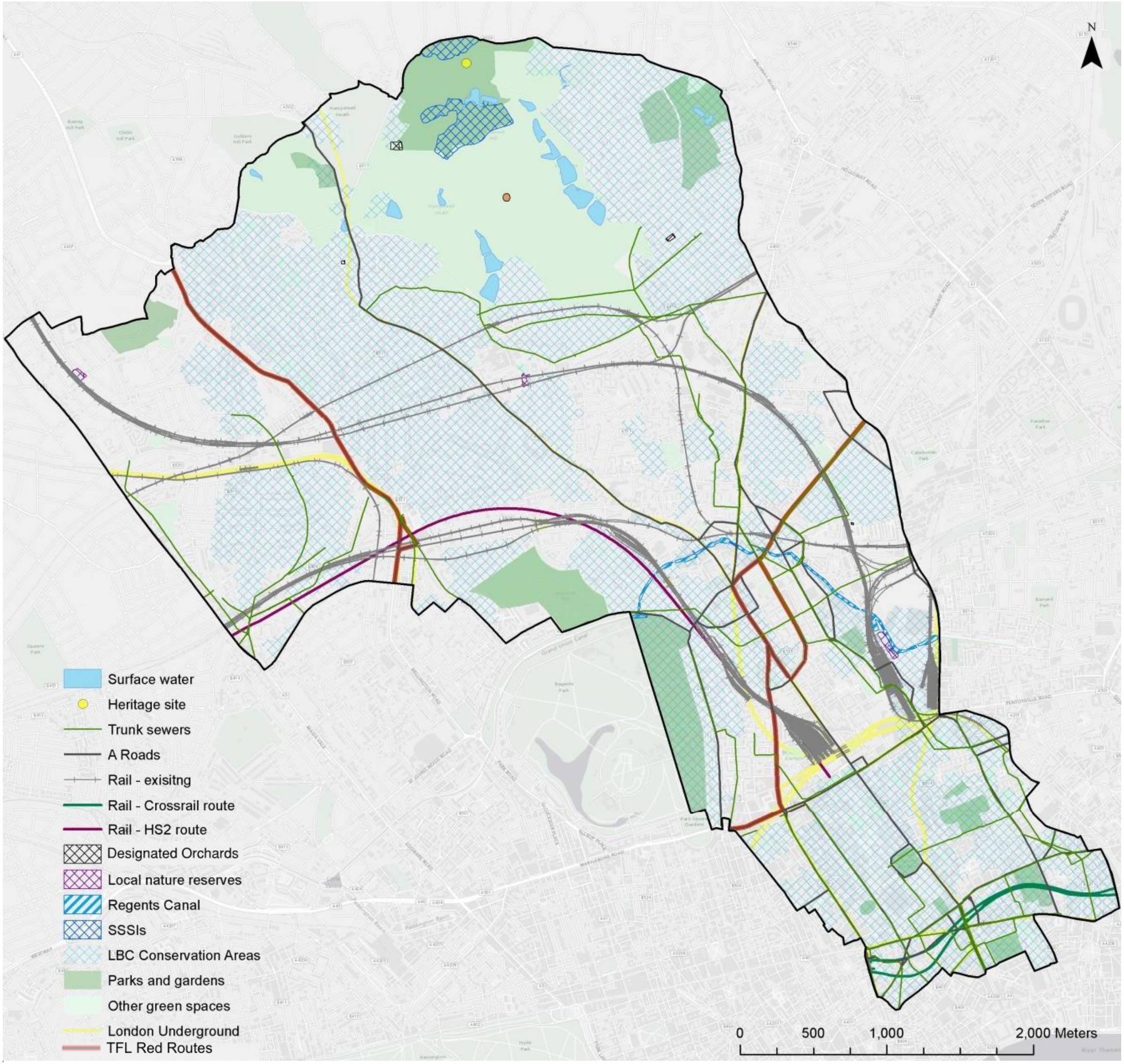


Figure 4—1 Borough wide physical constraints map

Conservation Areas

Camden has 39 conservation areas covering 11km^2 (approximately 50% of the Borough). Although these areas do not restrict the development of decentralised energy networks, they signify areas of land that have been designated as being of special architectural or historic interest and so are inherently areas more sensitive to new development. The visual impact of energy centres in these areas should be considered in more detail. Parts of the Borough not in conservation areas include regions around Kentish Town, King's Cross and east Kilburn.

Associated areas of conservation include local nature reserves and Hampstead SSSI, these are either small in nature or far from heat demand/supply centres and so are not considered a major constraint.

Above ground physical constraints

There are two TfL red routes running across the Borough, the A41 in the west and the A503 in the east. Public works in these roads are likely to cause significant disruption and cost therefore presenting obstacles to DEN. Camden is heavily constrained with rail tracks serving three major national rail stations, Euston, St Pancras and King's Cross. This heavily constrains the areas immediately north of these three stations where there are few available points to cross the tracks. Moving north there are more frequent crossing points of rail tracks which can be used as crossing points for network pipework. Between Chalk Farm and South Hampstead the rail lines are routed below ground and so present less of a constraint in this area.

Below ground physical constraints

Known below ground constraints have been mapped on Figure 4—1. In many cases these can be considered a source of waste heat as well as a constraint and may be of sufficient depth to not clash with DEN pipes. Trunk sewers are one constraint that can impose on pipe routings; for the most part these follow the main roads in the Borough. Care should be taken at a local level to minimise the number of road crossings across trunk sewers on grounds of the cost of mitigating and avoiding clashes.

5 Heat demand summary

The heat demand assessment has been carried out with a focus on anchor loads (tier 1 demands) across the Borough which represent the buildings most suited to connecting to a decentralised energy network. In total 468 GWh/yr. of tier 1 demands have been mapped. This represents approximately 24% of the estimated total heat demand of the Borough.[4]

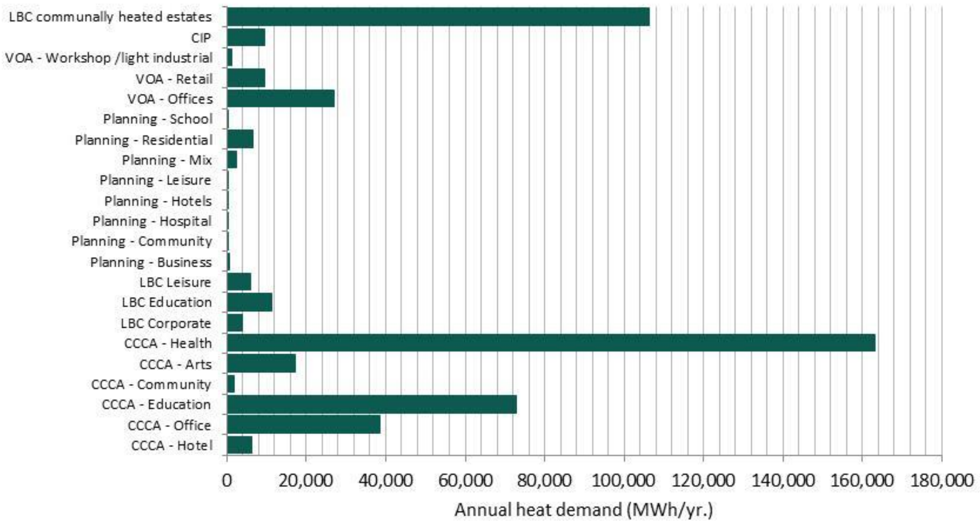


Figure 5—1 Tier 1 annual heat demands by data source

A spatial representation of these demands is given in Figure 5—2 overleaf and has been used to develop the clusters discussed in section 7. A density map overlay has been added to this map to highlight areas where the cumulative demand of multiple sites in the same area is significant. The density map is distorted in places where there is a single very large heat demand such as the Royal Free Hospital in the north of the Borough.

Tier 2 and tier 3 buildings (see Table 3—2) have been excluded from this map in favour of prioritising the tier 1 anchor loads. In total, there is an additional 304 GWh/yr. of tier 2 and 3 demands, increasing the total to 772GWh/yr., approximately 40% of the estimated total heat demand of the Borough.

These additional tier 2 and 3 loads should be investigated for any additional significant sites on a case by case basis once areas for heat network clusters have been selected based on tier 1 assessment. This next level of assessment does not form part of this study.

Borough wide maps showing all tier 1, 2 and 3 demands are given in Appendix A. A copy of Figure 5—2 showing an overlay of the heat network clusters discussed in section 7 is given in Appendix B.

[4] Based on DECC sub-national energy statistics

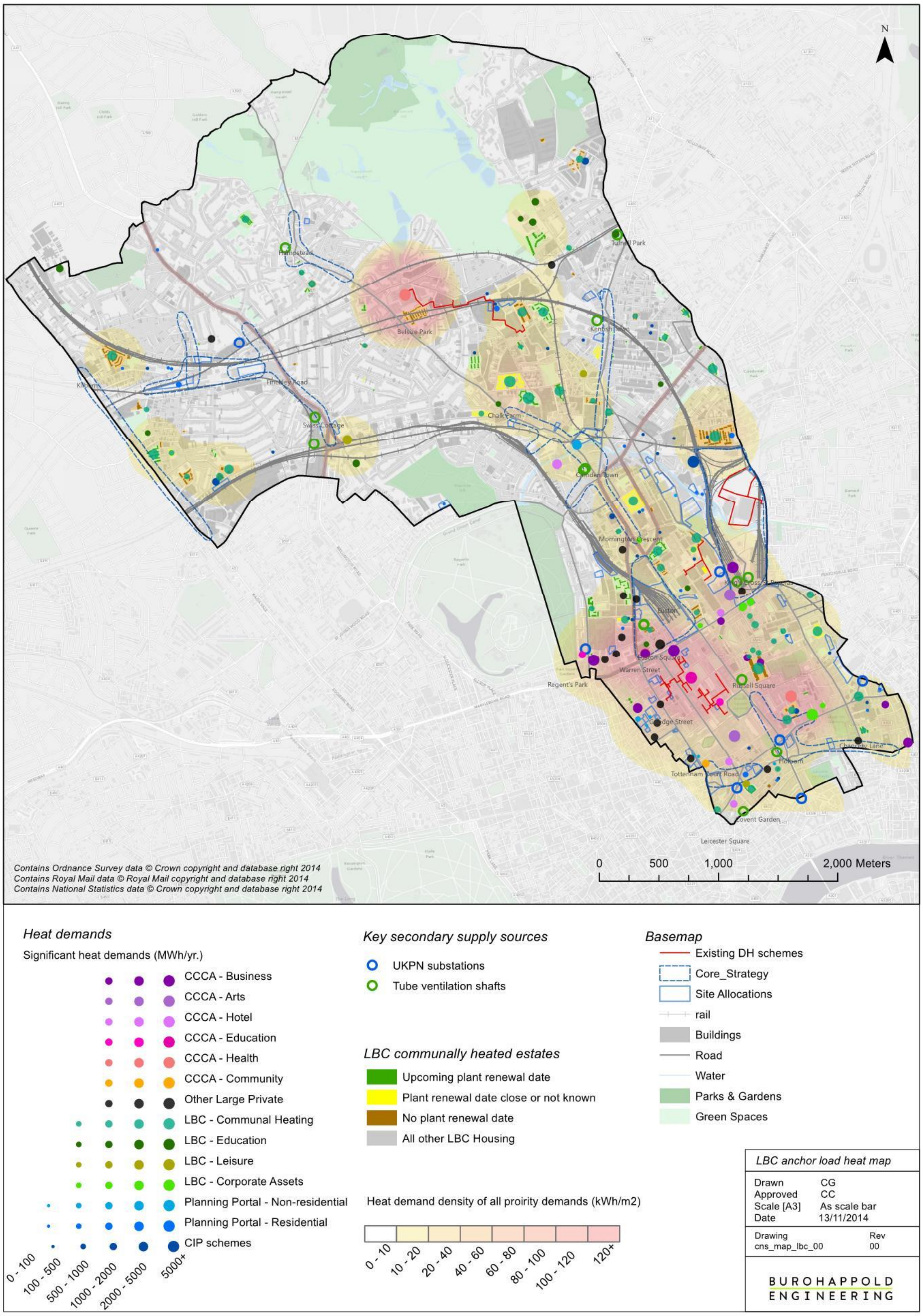


Figure 5—2 LBC anchor load heat map

6 Secondary heat supply

6.1 Borough wide assessment

A Borough wide assessment of secondary heat sources has been carried out across 12 heat source typologies covering significant environmental industrial and process sources of waste heat. The assessment has been carried out to determine the technical viability of capturing this waste heat for use as a low carbon heat supply source for decentralised energy networks. Assumptions for the recovery of heat at each source are taken from the GLA's secondary heat report[5] and include the use of heat pumps to raise the temperature of inherently low grade heat to connect to energy networks, at an assumed temperature of 70°C (a compromise between heat demand requirements and supply energy reduction).

These sources are not an exhaustive list but cover some of the most readily available and practical sources for recovering waste heat. These are:

- Ground source
- Air source
- River and canal
- Sewer heat rejection
- Industrial
- Electrical substation transformers
- Building cooling system heat rejection
- Non HVAC – supermarkets
- Non HVAC – data centres
- London Underground
- Water treatment works
- Power stations

A summary of the typical characteristics for each secondary heat source and their Camden specific resource is given in section 6.1.1 to 6.1.8. Where 'available' and 'delivered' heat are referred to separately the available heat refers to the heat at the temperature of the heat source, the delivered heat is the heat provided at an assumed temperature of 70°C to a decentralised energy network, accounting for the heat pump electricity required to raise the temperature from each heat source's latent temperature. Secondary heat sources are often unsuitable for use within a decentralised energy network, as discussed in Section 6.5.

[5] GLA. The Secondary Heat Report – Greater London Authority. *GLA, 2013*.

6.1.1 Ground source

Ground source heat systems are divided into two main categories, open systems (using aquifers) and closed loop (using sealed pipework). In both cases the available heat is distributed over a wide area of ground in relatively diffuse amounts. The amount of energy available from ground source schemes is subject to land availability and regulatory constraints by the Environment Agency.

Constraints on the availability of ground source heat are largely site specific; a conservative set of assumptions has been taken to gauge the potential resource across the Borough. A closed loop borehole system yielding 37kWh/m^2/yr.[6] has been assumed in each case, with land availability restricted to new building development sites identified in the LBC planning portal and education facilities; two building typologies for which space could be foreseeably made available for such systems.

An assumption of 10% of site footprints has been allocated for such systems[7] for education in playground and sports fields and for new buildings in public amenity spaces and beneath buildings. An allowance for using 10% of parks and gardens across the Borough has also been considered but not included in totals as this is seen for the most part to directly clash with conservation constraints (see Figure 4—1). The estimated heat available from ground source is shown in the table below. Although focused on open spaces, ground source systems can be retrofitted in existing sites where there is sufficient floorspace not occupied by buildings, such as amenity space on existing housing estates.

Table 6—1 Ground source heat resource

Typology	Total site area (m^2)	% of site eligible for boreholes	Total available heat (MWh/yr.)	Total delivered heat (MWh/yr.)
Education	387,000	10%	1,432	2,285
Site allocations	924,000	10%	3,420	5,456
		Total	4,852	7,741
Forest	*420,000*	*10%*	*1,553*	*17,993*
Park	*3,048,000*	*10%*	*11,279*	*28,210*

[6] BuroHappold 2012 summary of recommendations from sub consultant project specific study
[7] Based on Camden school installed systems (6% of site area) plus notional addition for sports pitch availability

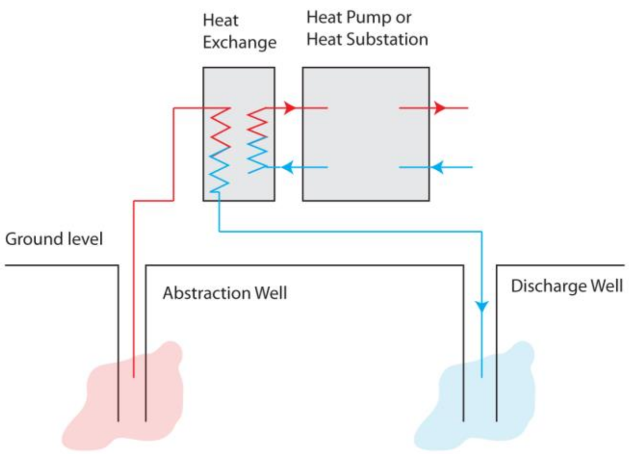


Figure 6—1 Principles of open loop ground source heat abstraction

Closed loop ground source heat systems are unlikely to be suitable for DEN integration as the quantum of heat that can be extracted from the ground over a localised area will be small. Open loop ground source heat systems using aquifers have potential to provide a higher quantum of heat but are very site specific depending on geological conditions and heat availability cannot be estimated without detailed ground investigation.

6.1.2 Air source heat pumps

Outside air at any temperature above absolute zero contains some heat, the quantity of which varies both seasonally and diurnally. Air source heat is available at a very low grade; there are no heating applications where this source can be used directly without heat pumps.

As with heat supply from other environmental sources there is no theoretical maximum supply from air source heat. Unlike ground source heat pumps it is hard to apply realistic constraints at a Borough level. Air source heat pumps have the highest electricity demand of all the sources considered in this study and are as such the least attractive in terms of energy costs and CO_2 emissions. Supplying heat at a district level would require large heat pumps consuming large quantities of electricity. This is reliant on their being spare capacity in the local UKPN network to accommodate the additional load. The location of large heat pumps would sensibly be restricted to within close proximity of electricity substations, with sufficient space to accommodate the required plant (~700m^2 for a large heat pump and associated ancillary equipment). Current UKPN spare capacity is unknown and constantly changing with the introduction of major developments including Crossrail and HS2. The GLA secondary heat report suggested, based on data available at the time of writing (2013), that large air source heat pumps could provide a maximum of 1,440 GWh/yr. of heat, requiring 414 GWh/yr. of heat pump electricity across Camden.

Should the cost and carbon intensity of electricity fall in future years the potential for large air source heat pumps at a district level should be investigated in further detail for each cluster however for the reasons given above this source has not been considered quantitatively against other sources in this study.

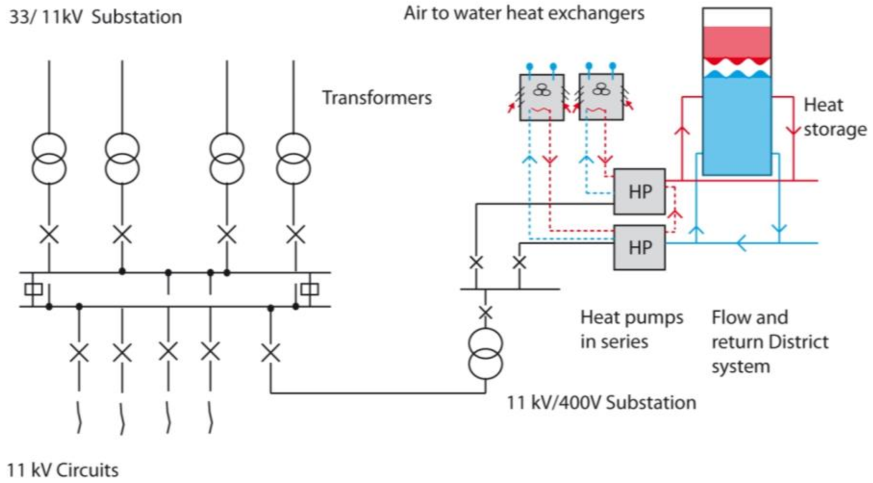


Figure 6—2 Principles of air source heat pump supply

6.1.3 River and canal

Subterranean rivers

There are no surface rivers in Camden however the Borough is situated above the largest subterranean river in the capital (River Fleet) as well as subterranean portions of the smaller Tyburn and Westbourne rivers. The River Fleet is a disused subterranean river flowing from two springs in Hampstead and Highgate, meeting at King's Cross and flowing into the Thames at Blackfriars Bridge. The approximate location of the river has been identified on the constraints map in Figure 4—1. Although a potential source of waste heat, this is of a low priority as flow characteristics and access will vary across the route and have not been determined at this stage.

Regent's Canal

Regent's Canal flows east to west along the centre of the Borough and is maintained by the Canal and Rivers Trust. There is recent precedent for small developments using the canal as a source for building scale heating and cooling (Waterhouse Restaurant, Hackney). Use of the canal as a secondary heat source is likely to be limited to smaller demands than typically associated with decentralised energy networks as canals have typically low flow rates when compared to rivers. No flow rate data was available for Regent's Canal for this study but from other canal measurements it can be expected to be $<1m^3/s$ for significant periods. For this reason, canals are more likely to be sensitive to temperature fluctuations due to the reduced mixing in the channel and the potential impact on the environment. For a 5MW heat pump, flow abstraction from the channel would typically be required at $\sim 0.3m^3/s$, this may be a significant proportion of the canal flow.

These assumptions are made prior to a site specific investigation of the potential of Regent's Canal as a secondary heat source. Although not considered in detail for the reasons given above, where clusters are in close proximity to the canal it is recommended that its potential as a resource is investigated further.

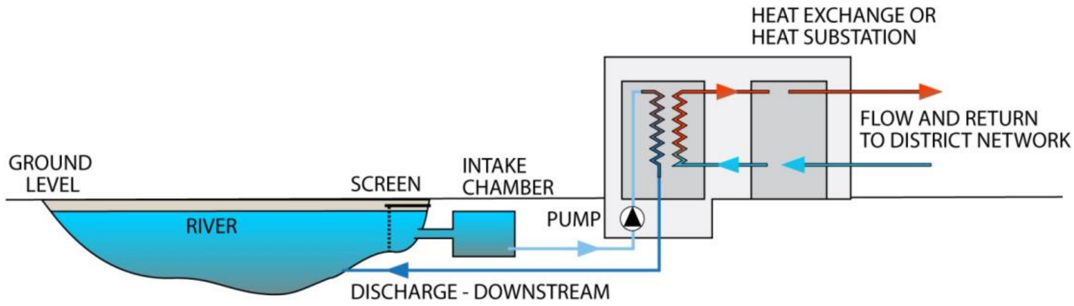


Figure 6—3 Principles of canal heat abstraction

6.1.4 Sewer heat rejection

Heat can be abstracted from sewers by diverting sewer flow into a chamber or series of chambers with screening used to maintain clear pump intakes. Sewage is then pumped to a specially designed large diameter shell and tube heat exchanger which is less prone to blocking than a standard heat exchanger. Heat is abstracted and cooled sewage is returned to the sewer downstream of the abstraction point. Sewer heat can also be recovered using 'in-line' heat exchangers. This method has been trialled as part of the EU funded Celsius project, for a heating scheme in Cologne, Germany.

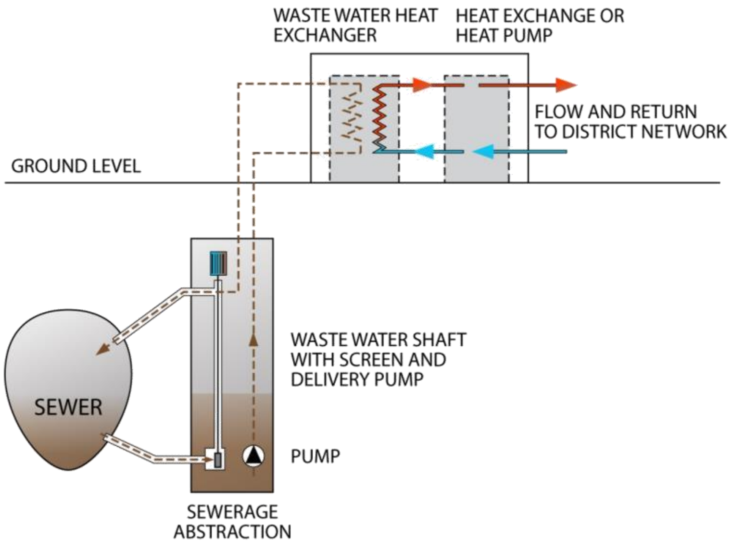
Sewer temperatures remain relatively stable throughout the year, a maximum temperature change of 5ºC has been assumed in heat abstraction calculations, based on a volume of sewerage calculated from the Borough population and an average daily water consumption of 197 litres/person/ day[8]

Table 6—2 Sewer heat resource

Total Sewerage Volume (m^3/ day)	Total available heat (MWh/yr.)	Total delivered heat (MWh/yr.)
42,263	93,000	134,000

There are a number of trunk sewers flowing through Camden from which sewer heat could be abstracted (see Figure 6—9). The viability of using sewers as a heat source is heavily dependent on access constraints such as sewer depth and access chamber locations, and sewage flow rates at specific locations. In order to determine viability detailed site specific information will be required, hence should be assessed on a case by case basis where clusters are co-located with sites overlaying major trunk sewers.

8 Derived from Environment Agency (2010) State of the environment report. http://www.environment-agency.gov.uk/research/library/publications/41051.aspx



Principles of sewer heat abstraction

6.1.5 Industrial

Industrial and power station heat recovery provides the highest grade of secondary heat, and heat can be recovered in a number of ways without impacting the efficiency of plant. Recovering heat from flue gases is a common method of heat recovery and is shown in the figure below.

Industrial processes with secondary heat potential have been identified by those registered under Local authority Integrated Pollution Prevention and Control (LA-IPPC) and Local Authority Pollution Prevention and Control (LAPPC). Camden has a lack of significant industrial plant from which heat could be recovered. A full list or registered processes is given below, none of which have significant quantities of waste heat associated with them.

Table 6—3 LBC Industrial processes

Process	No. of sites	Waste heat consideration
Dry cleaners	56	Small individually owned units, assumption that scale for heat recovery to DEN is not commercially viable
Vehicle re-sprayers	7	Not associated with secondary heat supply
Cement batchers	3	British Rail Goods Yard Wharf Road/off York Way – temporary site for Kings Cross construction, not suitable for secondary heat supply
Metal melting processes	1	Small jewellery scale establishment, not suitable for secondary heat supply
Petrol stations	9	Not associated with secondary heat supply

Larger industrial processes are registered separately with the Environment Agency as ‘Part A’ processes. There are no Part A industrial processes registered in in Camden.

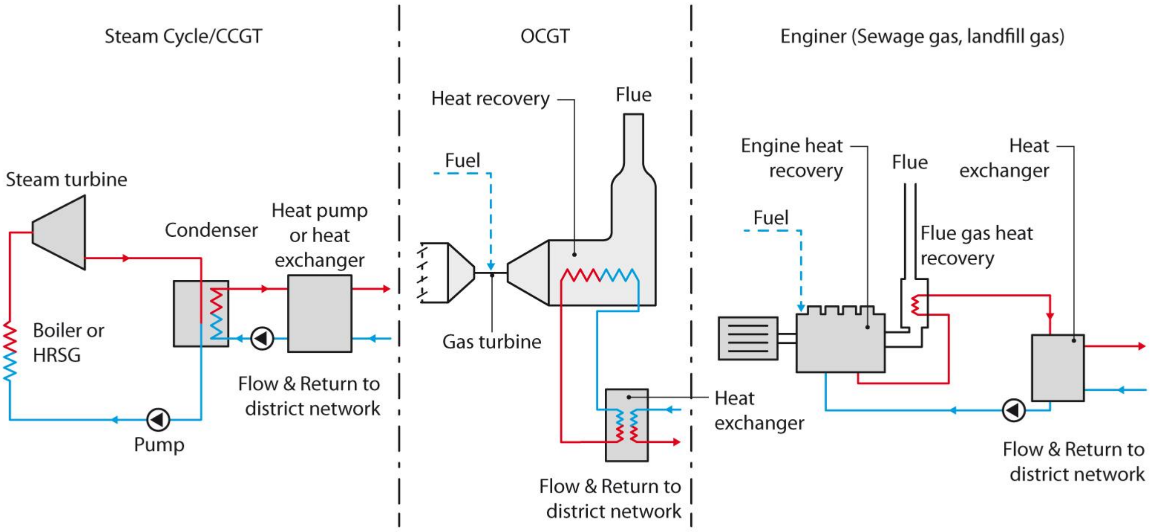


Figure 6—4 Principles of industrial heat abstraction

6.1.6 Electrical substation transformers

Electricity substations on both the transmission and distribution networks contain transformers to convert power from one voltage to another. Transformer coils are usually cooled and insulated by being immersed in insulating oil, which heats up. Heat can be abstracted from this insulating oil.

The quantity of heat available from any substation is dependent upon the peak load of the transformers in the substation, their load factor, efficiency and recoverability of heat. Information on the peak loading and location of each substation is protected by UKPN. An approximate estimate of the average quantum of heat available has been taken from the results of the GLA secondary heat study based on average assumptions of the temperature of transformer cooling oil and loading of substations. Specific details relating to each substation transformer are not made publically available; where opportunities exist these are identified for future assessments requiring more detailed consultation with UKPN.

Table 6—4 Substation transformer heat resource

Substation transformer	Estimated available heat (MWh/yr.)	Estimated delivered heat (MWh/yr.)
Kingsway	Approximately 800-1,000 per substation transformer, site dependant.	1,100-1,300 per substation transformer
Shorts Gdns		
Fisher St		
Back Hill		
Back Hill A		
Longford St		
St. Pancras A		
St. Pancras B		
Lithos Rd A		

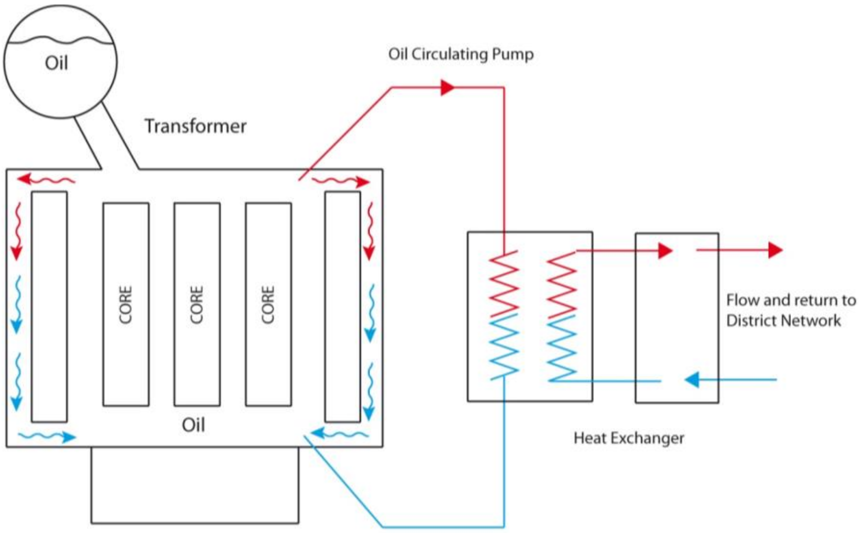


Figure 6—5 Principles of substation transformer heat recovery

6.1.7 Building cooling system heat rejection

Building cooling systems typically reject heat at low temperatures through the use of air or water cooled chillers. The VOA and non-domestic planning databases from the heat demand study have been used to quantify the predicted extent of commercial scale office and retail building cooling across Camden. Heat rejection has been determined based on the cooling benchmarks given in Appendix B and an assumed seasonal chiller COP of 2.59. A notional minimum cut-off has been applied to limit recovery to commercial scale cooling plant with an installed capacity of over 100kW. The estimated heat available from building cooling system heat rejection is shown in the table below.

Table 6—5 Building cooling system heat resource

Non-domestic	Number of addresses	Total available rejected heat (GWh/yr.)	Total delivered heat (GWh/yr.)
Existing (VOA database)			
All buildings with cooling assumed	17,526	236	321
All buildings with cooling capacity over 100kW	1,299	143	195
New build (planning portal)			
All buildings with cooling assumed	40	5	7
All buildings with cooling capacity over 100kW	22	5	6

[9] CIBSE Guide F: Energy Efficiency in Buildings. *CIBSE, 2012*

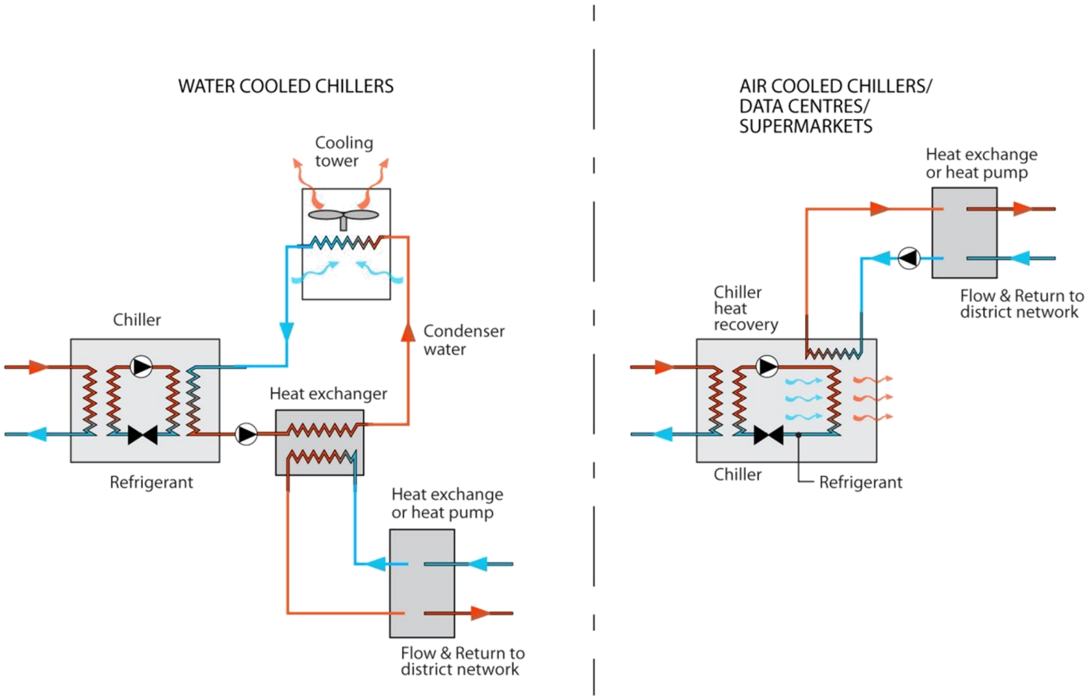


Figure 6—6 Principles of building cooling system heat recovery

6.1.8 Non HVAC building heat rejection

Some buildings reject heat from equipment other than building cooling systems such as from food refrigeration and IT equipment. Large supermarkets and data centres are the two best examples of such sources with potential for secondary supply.

Supermarkets

For refrigeration in supermarkets, total heat rejected is calculated from benchmark cooling loads (W/m^2) for different refrigeration types (e.g. freezers, cold food counters) as applied to estimated freezer / refrigerator size (m^2) per refrigeration type, per store and estimated utilisation. Location data for large supermarkets in Camden has been obtained from open source point of interest databases. The estimated heat available from supermarket refrigeration system heat rejection is shown in the table below.

Table 6—6 Major supermarket chain secondary heat resource

Major supermarket chain	Total available rejected heat (GWh/yr.)	Total delivered heat (GWh/yr.)
M&S	722	985
Tesco express	1,588	2,166
Co-Op	1,155	1,575
Morrisons	578	788
Sainsbury	2,022	2,757
Waitrose	578	788
Total	6,643	9,058

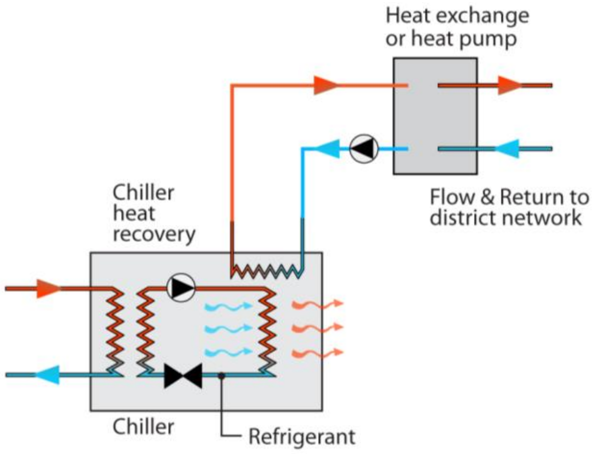


Figure 6—7 Principles of supermarket chiller heat recovery.

Data centres

A review of publically available information (http://www.datacentermap.com) and consultation with C4L (leading data centre provider) suggests that there are no significant data centres within the Borough. Security concerns surrounding data centre locations may mean that there are existing unknown sites, however none could be located for assessment at this time.

6.1.9 London Underground

Heat generated underground through train braking, lighting and passengers is rejected through ventilated shafts at strategic positions along the network.

The quantity of heat available is dependent upon the exhaust air temperature and flow rate. Data on tunnel temperature from TFL's London Underground network has been used to estimate the total heat available from ventilation shafts across the Borough. The available heat is assumed to be the same in each case, heat delivered will vary depending on changing tunnel temperatures. In each case a delta T of 7°C is assumed across the heat pump based on typical parameters for commercially available heat pumps.

Average assumptions from this data have also been applied to three new proposed ventilation shafts being installed as part of the HS2 developments at Adelaide Road, Alexandra Place and Cobourg Street.

Table 6—7 Underground ventilation shaft heat recovery estimates

Ventilation Shaft	Operator	Total available rejected heat (MWh/yr.)	Total delivered heat (MWh/yr.)
Covent Garden	TfL	130 per shaft	180-200 per shaft
Bethnal Green	TfL		
Holborn	TfL		
Russell Square	TfL		
Drummond Street	TfL		
Cobourg Street	TfL		
King's Cross	TfL		
King's Cross St. Pancras	TfL		
Camden Town	TfL		
South Kentish Town	TfL		
Adelaide Road	TfL		
Swiss Cottage	TfL		
Kentish Town	TfL		
Liverpool Street	TfL		
Hampstead	TfL		
Tufnell Park	TfL		
Adelaide Road	HS2		
Alexandra Palace	HS2		
Cobourg Street	HS2		

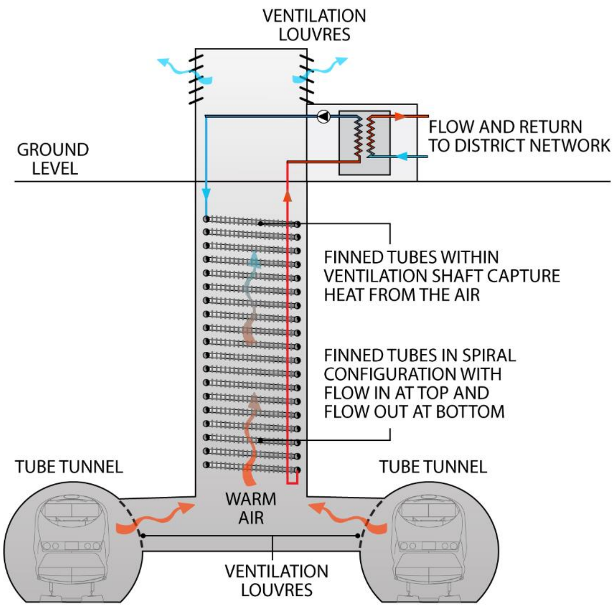


Figure 6—8 Principles of underground ventilation shaft heat recovery

6.1.10 Power stations

A review of the digest of UK energy statistics[10] confirms that there are no power stations located in Camden. The nearest power station is Taylor's Lane power station, a 132MW open cycle gas turbine located in Willesden, approximately 7km west of the Borough. This site has not been considered further at this time as the demands in the London Borough of Brent are considered more suitable for connection given their proximity to the power station.

6.1.11 Water treatment works

There are no water treatments works in or near Camden. Beckon sewage treatment works, the largest such site in Europe, is the closest large water treatment works, approximately 20km east of the Borough.

6.2 Secondary heat source map

Figure 6—9 illustrates the quantum and location of secondary heat sources discussed in section 6.1. The heat rejection quoted is 'available' heat, i.e. that recovered directly from each site at its source temperature. This does not account for the energy required to upgrade the heat to a useable temperature for DEN (see section 6.3).

For linear sources (canals, rivers, sewers) the quantum of heat has not been shown as this is dependent on the location of abstraction which is theoretically unrestricted along each length. Ground source heat may be equally unrestricted in its location – the points shown in Figure 6—9 are indicative based on the methodology set out in section 6.1.1.

[10] DECC. Digest of UK energy statistics (DUKES). DECC, 2013

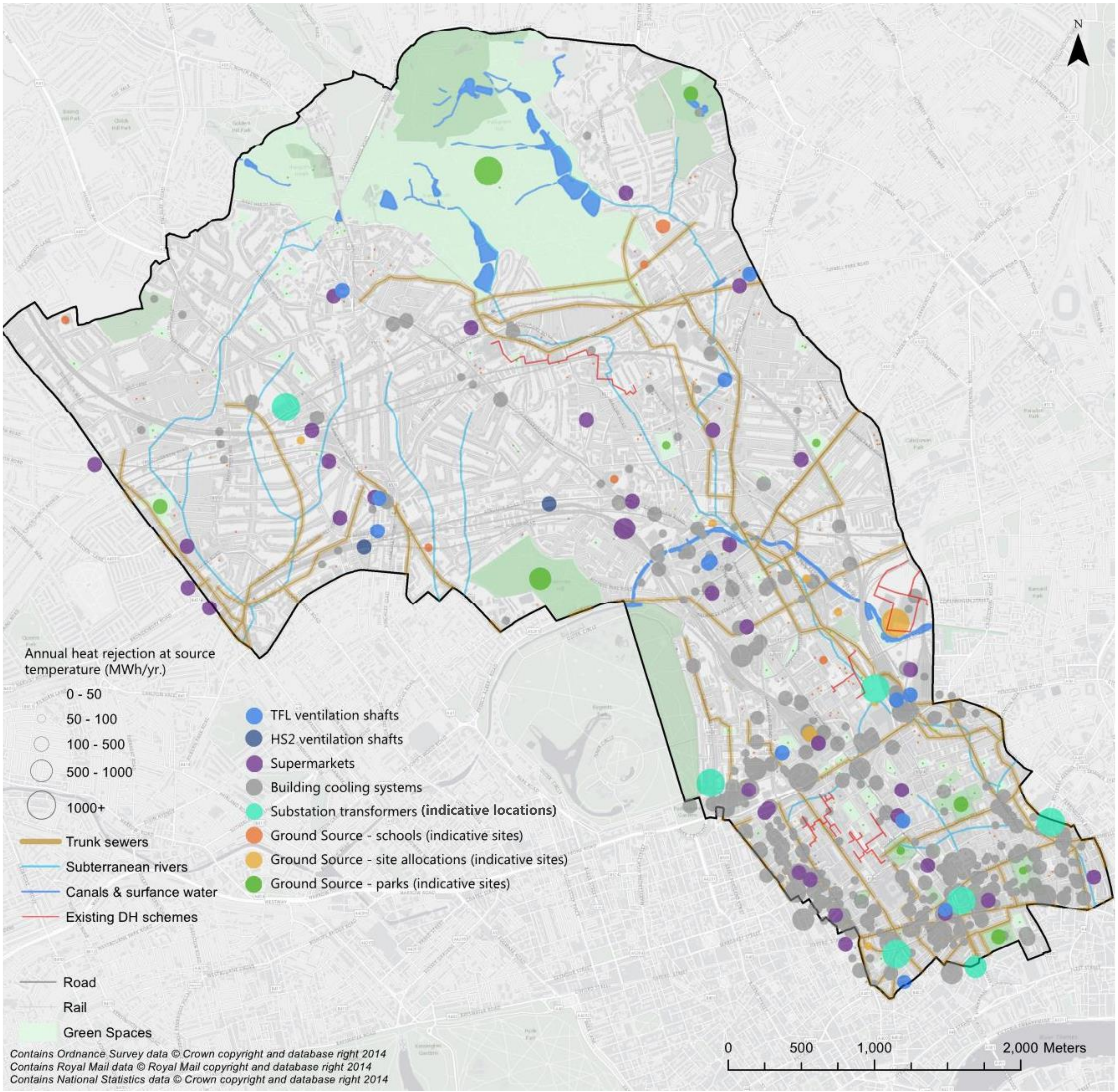


Figure 6—9 Camden secondary heat source map

6.3 Heat supply comparison

Table 6—8 summarises the secondary heat supply options discussed in section 6.1. All costs are for typical heat recovery and heat pump infrastructure, derived from the GLA secondary heat report and do not include any heat network costs. Heat pump energy costs are based on 'levelised' costs assuming an electricity cost of 7.1p/kWh discounted over a 20 year life at 3.5%.

Table 6—8 Camden secondary heat supply source comparison

Source	Typical heat rejection temperature (°C)	Infrastructure capital cost (£m)	Infrastructure cost (p/kwh)	Heat pump energy cost (p/kWh)	Total cost (p/kWh)	Tonnes of CO_2 per MWh	Total available rejected heat (MWh/yr.)	Total electricity required (MWh/yr.)	Total delivered heat (MWh/yr.)
Ground source (closed loop)	13	1.3	1.3	2.4	3.7	182	4,900	2,900	7,700
Air source	2-16	0.4	1.1	3.1	4.2	240	-	-	-
River and canal source	5-20	1.3	0.5	2.0	2.5	156	-	-	-
Sewer heat mining	14-22	0.1	0.6	2.2	2.8	168	93,000	41,000	134,000
Industrial sources	70	0.2	0.6	0.0	0.6	0	-	-	-
Electrical substations	35	0.1	1.8	1.0	2.7	75	16,200	5,200	21,300
Office (HVAC)	28	6.8	1.6	1.6	3.2	124	148,000	53,000	201,000
Non-HVAC - supermarkets	28	0.1	0.5	1.5	2.0	114	6,600	2,400	9,100
Non-HVAC - data centres	28	0.2	0.8	1.2	2.0	94	n/a	n/a	n/a
London Underground	12-29	6.8	1.8	2.1	3.9	159	2,400	1,000	3,300
Water treatment works	14-22	1.1	0.6	1.6	2.2	3	n/a	n/a	n/a
Power station rejection	35	6.8	0.4	1.3	1.7	98	n/a	n/a	n/a
						Total	271,100	105,500	376,400

In total there is an estimated 271 GWh/yr. of low grade secondary heat available which would require an additional 105 GWh/yr. of heat pump electricity to in turn supply 376 GWh/yr. of high grade heat to decentralised energy networks.

6.4 Cost and carbon

The sources of most interest for decentralised energy networks are those available at the highest temperatures with the lowest cost of supply. CO_2 emissions associated with each source can be calculated from the energy required to uplift source temperatures (assumed for supply to a DEN at 70°C).

The relationship between cost and carbon for the sources in Table 6—8 is shown in Figure 6—10 below based on current fuel prices and CO_2 emission factors used in the GLA secondary heat report. The magnitude of heat available is indicated by the size of the bubbles. The sources of most interest are those in the bottom left of the graph, these have the least cost and carbon emissions associated with their supply. The dotted lines indicate the cost and carbon of providing equivalent heat from a counterfactual case of large gas boilers (GLA secondary heat report). Heat recovery from supermarkets is the only source available in Camden with a cost (accounting for infrastructure and heat pump demands over a 25 year life) less than that of conventional gas boilers. This is in part due to the higher grade heat available from supermarket refrigeration heat rejection. Though installation costs are high, the heat pump fuel costs over the life of such a scheme are predicted to be less than the gas costs for a conventional gas boiler.

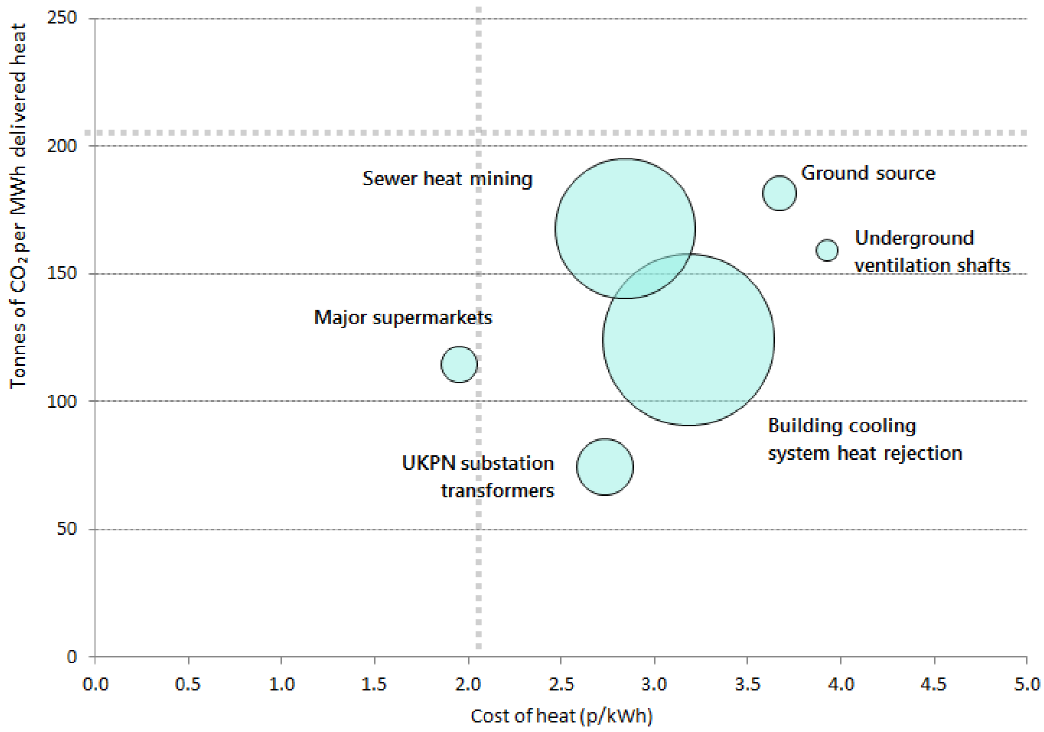


Figure 6—10 Camden secondary heat source prioritisation

6.5 Practical considerations and heat source prioritisation

The Borough wide assessment of secondary heat does not account for the practical considerations of connecting secondary heat sources to decentralised energy networks. In each case recovering secondary heat from existing sources will require varying degrees of retrofit and innovation. To minimise the commercial and technical challenges associated with connecting to secondary heat sources the most viable sites are likely to be public sector owned large point sources of heat.

Sewer heat mining, canal heat recovery, supermarkets and building cooling system heat recovery are examples of sources where the overall resource is high but the quantum of heat at any one site is restricted and the ownership of assets may cause commercial barriers to securing heat sale agreements. These sites are less likely to justify the initial investment required for mechanical system conversion and, in the case of supermarkets and offices, are likely to have a balance of heating and cooling demands for which building based heat recovery may be a more appropriate solution.

Canal heat recovery has not been prioritised because of the uncertainty surrounding the environmental impacts of abstracting flow from the canal. Following a number of forthcoming river source heat pump schemes currently under development this may become a source more attractive in the future and should be considered in further detail where a demand led scheme is in close proximity to the canal.

A qualitative comparison of factors affecting choice of secondary heat source for network supply is given below in Table 6—9. Data to support the ranking of score is taken from Table 6—8

Table 6—9 Camden secondary heat source prioritisation

Source	Overall priority	Grade of heat	Quantum of heat per site	Cost of heat supply	CO_2 per unit of heat delivered	Camden specific sites	Proven technology / ease of heat source adaption	Anticipated stakeholder interest
Electricity substations	High	med	med	high	high	high	med	high
London Underground	High	med	low	low	med	high	med	high
Non-HVAC - supermarkets	Med	med	low	high	med	med	med	low
Office (HVAC)	Med	med	low	low	med	high	med	low
Sewer heat mining	Low	low	low	high	med	med	low	low
River and canal source	Low	low	low	med	med	low	high	low
Ground source (closed loop)	Low	low	low	med	med	med	low	low
Air source	Low	low	high	low	low	low	med	low
Power station rejection	n/a	high	high	low	high	n/a	high	high
Industrial sources	n/a	high	med	high	high	n/a	high	high
Non-HVAC - data centres	n/a	med	med	high	high	n/a	low	med
Water treatment works	n/a	low	high	med	med	n/a	high	high

Two sources have been prioritised for the cluster assessments; substation transformer heat recovery and tube ventilation shaft heat recovery. Both sources have precedents for heat recovery retrofits in London, for transformers the Bank UKPN substation as part of the Tate Britain refurbishment, for ventilation shafts, Phase 2 of the Islington Bunhill network.

Other secondary heat sources within the clusters boundaries have not been investigated further at this time. Market testing through engagement with the relevant stakeholders is recommended prior to a more detailed feasibility study.

6.6 Connection to DEN clusters

There are no secondary heat sources identified with a heat supply potential sufficient to provide the baseload heat supply of a typical network cluster. As such the location of DEN clusters has been driven by anchor heating loads across the Borough over secondary supply sites. The primary heat supply in each case is assumed as a mix of CHP gas engines and gas boilers: secondary heat has been considered where coincident in location to DEN clusters and of significant scale to merit network supply as compared to supplying heat to a building.

Table 6—10 below shows the predicted carbon savings for the secondary heat sources identified for four of the clusters in section 7. In total, 22 GWh/yr. could be utilised, predominately through the recovery of electrical substation heat. As it is assumed that secondary heat supply would offset CHP supply in meeting the baseload heat demands there is no current CO_2 saving associated with switching supply source. Although giving a saving of 850 tCO_2/yr. across all clusters, this is less of a saving than that associated with conventional CHP, due to the discounting of emissions associated with CHP electricity export and the low gas emissions factor. This saving increases for a 2035 scenario given the projected decarbonisation of the electricity grid, to an equivalent level of a gas CHP led scheme currently. The benefits of connecting secondary heat to DEN are therefore seen as long term and associated not solely with carbon savings, but with the future need to migrate from gas to other low carbon fuels to improve the security of supply as gas resources become less readily available.

Table 6—10 CO_2 savings from cluster secondary heat sources

Cluster			Heating emissions (tCO_2/yr.)				Heating CO_2 savings		
	Secondary heat supply (MWh/yr.)	Heat pump electricity (MWh/yr.)	Counterfactual (individual gas boilers)	Gas CHP led energy centre	Inc. secondary heat (2015)*	Inc. secondary heat (2035)#	Gas CHP led energy centre	Including secondary heat (2015)*	Including secondary heat (2035)#
Kilburn	2,900	700	2,940	2,270	2,410	2,110	23%	18%	28%
South Camden	5,800	800	2,650	1,980	2,140	1,790	25%	19%	32%
Russell Square	300	100	6,480	4,880	4,910	4,870	25%	24%	25%
Great Ormond St	13,400	1,800	13,720	10,090	10,440	9,660	26%	24%	30%

*based on an electricity emission factor of 0.519 kgCO2/kWh[11]

based on an electricity emission factor of 0.082 kgCO2/kWh[12]

[11] Fuel prices, emission factors and primary energy factors. SAP version 9.92 (2013)
[12] DECC Marginal emissions factor. Valuation of energy use and greenhouse gas emissions for appraisal and evaluation (2014)

6.7 Other renewable heating systems

The capacity for other renewable heating systems from primary heat sources has not been assessed in this report but could include supply form biomass, anaerobic digestion and solar hot water. These sources have been assessed in the Mayors Decentralised Energy Capacity Study (2011) which suggests that solar hot water across the Borough could provide 1.8 GWh/yr. of heat (0.09% of the total Borough demand) based on installations on 25% of all domestic properties, 80% of all industrial properties and 50% of all new properties. The quantum of heat in this case is hard to predict because of the many site specific restrictions to providing solar hot water, a technology primarily focused on the building rather than the district scale. Heat from anaerobic digestion and biomass have been currently been discounted as a significant supply source in favour of gas CHP because of the lack of space and air quality concerns in central London Boroughs. Further investigation is required to quantify these constraints on a site by site basis.

6.8 Conclusions and recommendations

The secondary heat resource across Camden is dominated by a range of medium scale commercial and environmental sources with no single large loads to provide significant quantities of waste heat.

In total there is an estimated 271 GWh/yr. of low grade secondary heat available which would require an additional 105 GWh/yr. of heat pump electricity to in turn supply 376 GWh/yr. of high grade heat to DEN. No single secondary heat source is large enough to have a large impact on the heat supply to potential network clusters and so the cluster selection is based on heat demand anchor loads over supply sources.

Where secondary heat sources are evident within the cluster areas (see Appendix B) these have been investigated in further detail in section 7, namely for electricity substations and tube ventilations shafts. These sources have been prioritised as the most viable of the 12 heat sources investigated. Other sources identified in this study may hold potential, but require further research and stakeholder engagement before they can be progressed further.

In total an initial 22 GWh/yr. of secondary heat supply has been identified for integration into decentralised energy networks. The carbon benefit of connection to secondary heat sources is reliant on the decarbonisation of the electricity grid, as all sources identified are of a low grade and require heat pump electricity to upgrade heat temperatures to supply conventional decentralised energy networks.

7 Heat Network Clusters

Six heat network clusters have been selected for further analysis based on the tier 1 anchor load map in Figure 5—1 and are shown in

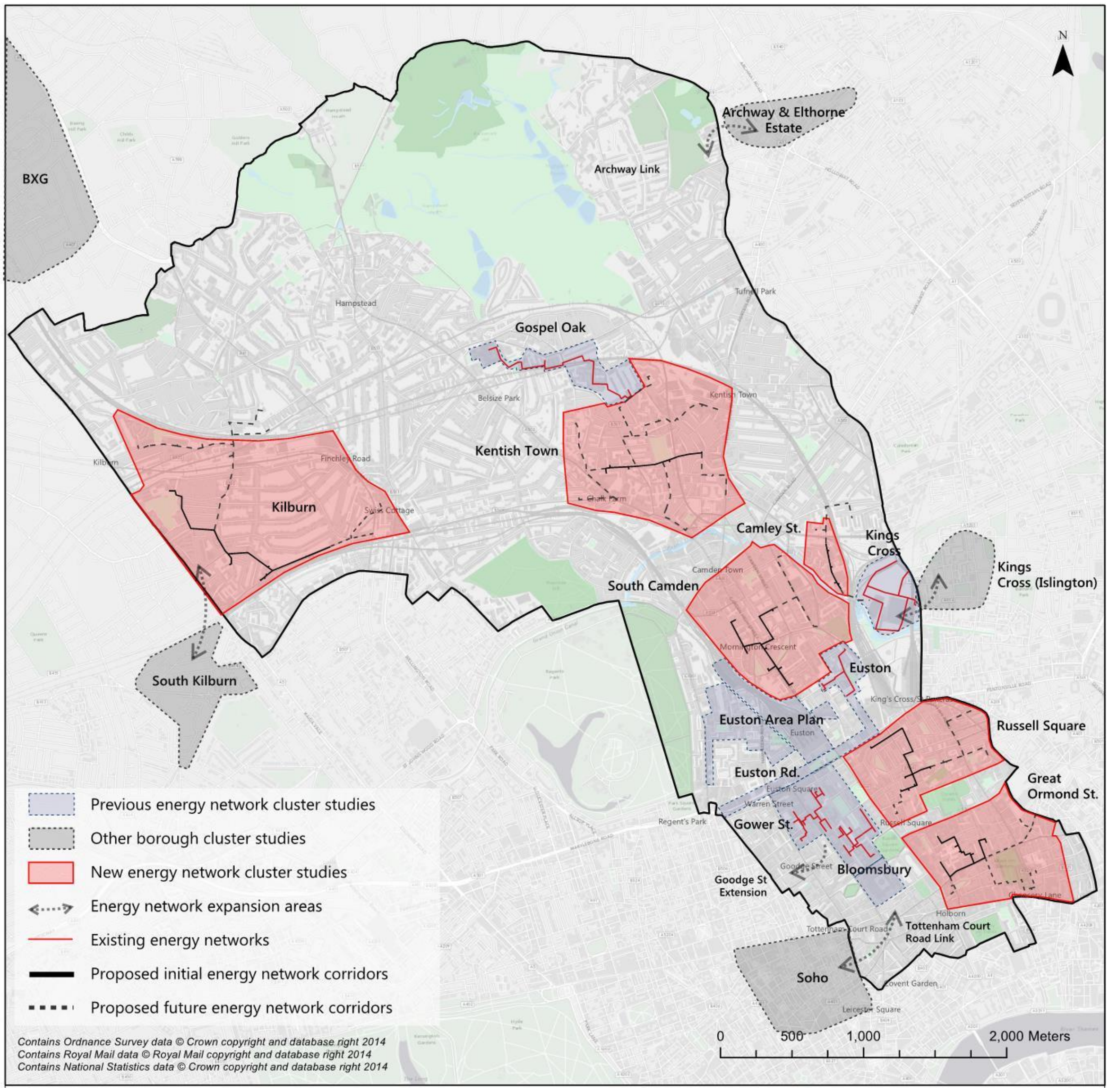


Figure 7—1 overleaf. This is in addition to the five existing clusters, discussed alongside other expansion opportunities in section 7.7. Boundaries for load connections in each cluster are based on the constraints map in Figure 4—1, with details of the building connected to each cluster set out in the following sections. These clusters overlap with some of the findings in the 2007 LBC heat mapping study and have been assessed again in more detail considering a wider number of potential building connections.

Although considered as distinct clusters in this study, the four clusters in the south of the Borough could be grouped as a smaller number of larger clusters. The physical barriers separating these areas are not insurmountable; the size of clusters may grow, depending on the capital available for each scheme, the number of buildings signed up to a scheme and the appetite of a developer to own and operate each network. The clusters presented are therefore seen as a 'phase 1' with the potential to connect as part of a future Borough wide view towards decentralised energy networks.

A summary of demands relating to the six clusters is given in Table 7—1. Each cluster is discussed in detail in the following sections. The secondary heat supply quoted is the capped demand after considering the local available sources in each cluster (discussed per cluster in section 7.1 to 7.7).

A full breakdown of all buildings and heat demands by cluster is given in Appendix E.

Table 7—1 Building heat demands by cluster

Cluster	Number of building connections	Initial network heat demand (MWh/yr.)	Additional mapped future heat demand (MWh/yr.)	Potential for secondary heat supply (MWh/yr.)
Kilburn	9	10,900	7,000	2,900
Kentish Town	5	21,500	9,800	-
South Camden	11	9,800	-	3,300
Russell Square	16	24,000	1,100	200
Great Ormond St.	6	50,800	3,800	7,600
Camley St	5	11,800	-	-

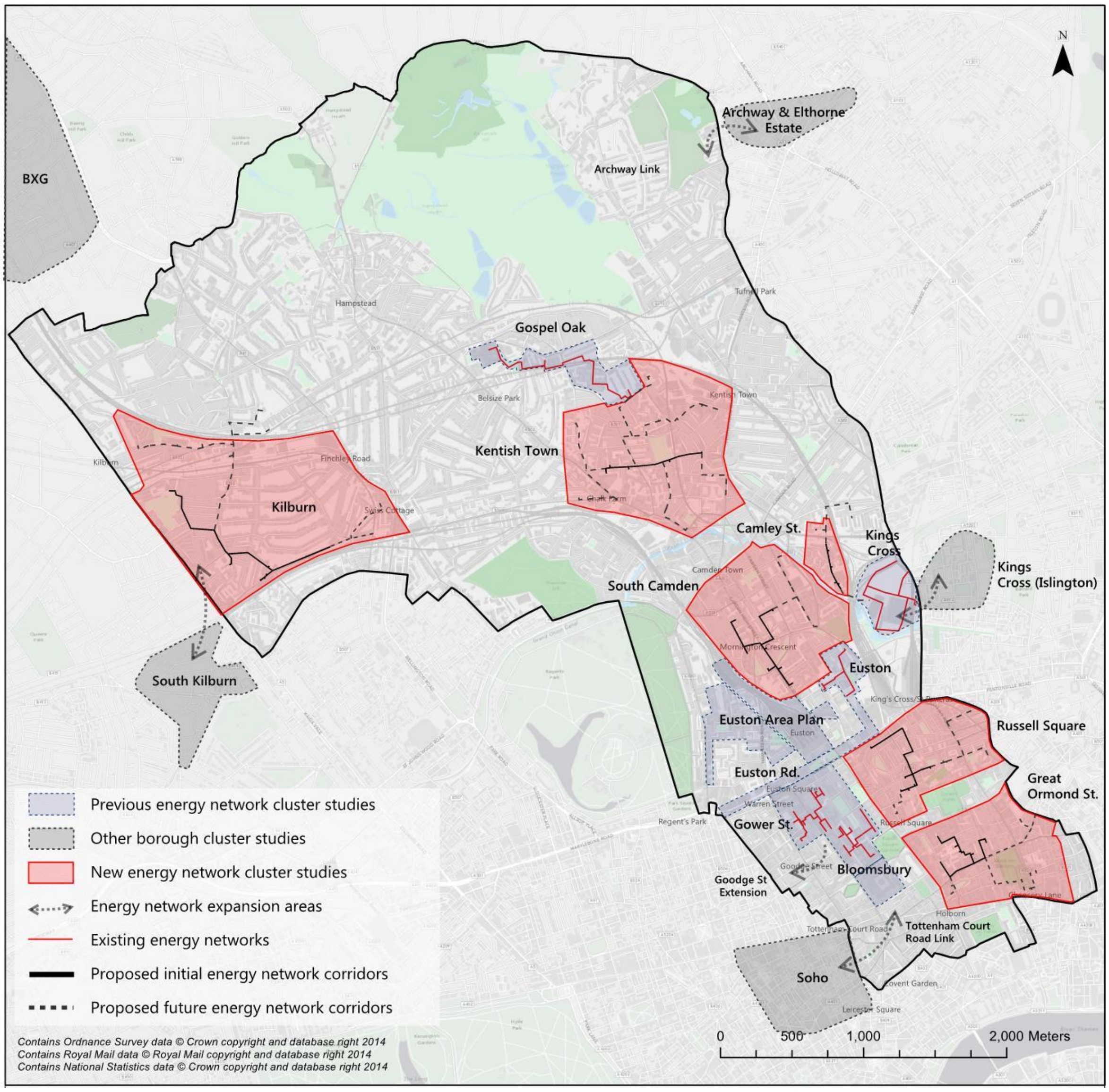


Figure 7—1 Decentralised Energy Network Clusters

7.1 Kilburn

Initial Network Corridors

The Kilburn cluster is an LBC housing led cluster connecting six communally heated estates in the western corner of the Borough with the Kingsgate Primary School and areas for potential future development along Belsize Road. In the south Abbey Road CIP provides a new scheme with the potential to act as a catalyst for this cluster, replacing the existing community centre, Co-op office and health centre with 240 new homes and 2,500m^2 of new community space. The Abbey Road CIP is being brought forward in three phases with a site-wide heat network serving the development. This site also provides a possible area for locating an energy centre, on LBC owned land.

St Mary's Mews Estate has been identified on the map as a communally heated estate in close proximity to the initial network and with heating plant approaching its renewal date. It is not currently connected to the scheme as the calculated heating demand (481 MWh/yr.) is less than the set threshold for consideration. Given the strategic benefits of connecting this estate, it is recommended that this estate is considered as a potential additional load to the initial scheme.

Future Network Corridors

A northern extension to this scheme has been identified connecting a number of new build developments in the area along with the communally heated West End Sidings Estate and Hampstead Cricket Club. This extension also incorporates the Hampstead Garden Centre site allocation as part of the West Hampstead Interchange core strategy area. The northern extension is of interest because the new build developments can be future proofed for DEN connection, however the timeframe of connection is likely to mean that individual heating systems will be provided in the first instance, with connection to a DEN dependant on the avoided cost of maintaining near new heating plant, unless DEN connection can be enforced through the planning process.

Secondary Heat

The northern extension to this cluster also enables the potential connection to Lithos Road substation as a potential source of secondary heat. Secondary heat from this substation could provide ~2,500 MWh/yr. of heat supply to the network, when upgraded to 70°C using ~600 MWh/yr. of heat pump energy. This represents 14% of the total cluster demands and 23% of the initial network loads.

Additionally, two tube ventilation shafts have been identified to the east of the cluster. Connection to these as a supply source is less attractive than connection to the substation, providing 400 MWh/yr. of heat; 2% of the initial network loads. The tube ventilation shafts are closer to the initial network (~500m) than connection to the UKPN substation (~1,000m should the northern extension not be forthcoming).

Connection into existing clusters

There are no existing DEN clusters close to the Kilburn cluster. As part of the regeneration of South Kilburn, Brent Council are planning to install a neighbourhood heating system. This scheme is located approximately 750m by road from the proposed Kilburn scheme. The major physical constraint of connecting these schemes is routing heating pipe 180m along Kilburn High Rd to cross the east-west railway tracks.

Conclusions and recommendations

Phase 1 of the Kilburn cluster is one of the smallest clusters considered in this study, connecting 10,900 MWh/year of heat demand, centred around the Kingsgate Road estate, Casterbridge and Snowman estates, and Abbey Road CIP. The cluster is located between the Jubilee line to the north and the Overground line to the south, with the future northern extension to the scheme requiring connection over the Jubilee line and Thameslink railway line, but providing opportunity in the form of new developments which can be future proofed for DEN connection.

Secondary heat sources in this cluster include the Lithos Road substation, and TfL ventilation shafts at Swiss Cottage and Adelaide Road could provide 2,900 MWh/year of heat supply, around 27% of cluster heat demand, though complex heat pipework routing is likely to be required due to the multiple railway lines in this cluster. It is recommended that the Abbey Road CIP development is reviewed for suitability to house an energy centre.

Development of this cluster is subject to a number of deliverability concerns noted in addition to the findings of the technical feasibility study. The following recommendations are set out as key objectives to determine the viability of this network for further consideration:

- Consultation on communally heated estates and Kingsgate Primary school to understand current heating system arrangements and interest in connecting to a DEN
- Determination of timeframe of CIP schemes and potential for DEN future proofing of new developments, both in the initial network and in relation to future northern extensions,
- Detailed constraints assessment to validate pipe routes and crossing of railway lines, particularly in relation to legal or cost implications
- Consultation with UKPN to understand proposals for Lithos Road substation and potential for heat recovery
- Detailed feasibility study of cluster loads including techno-economic assessment

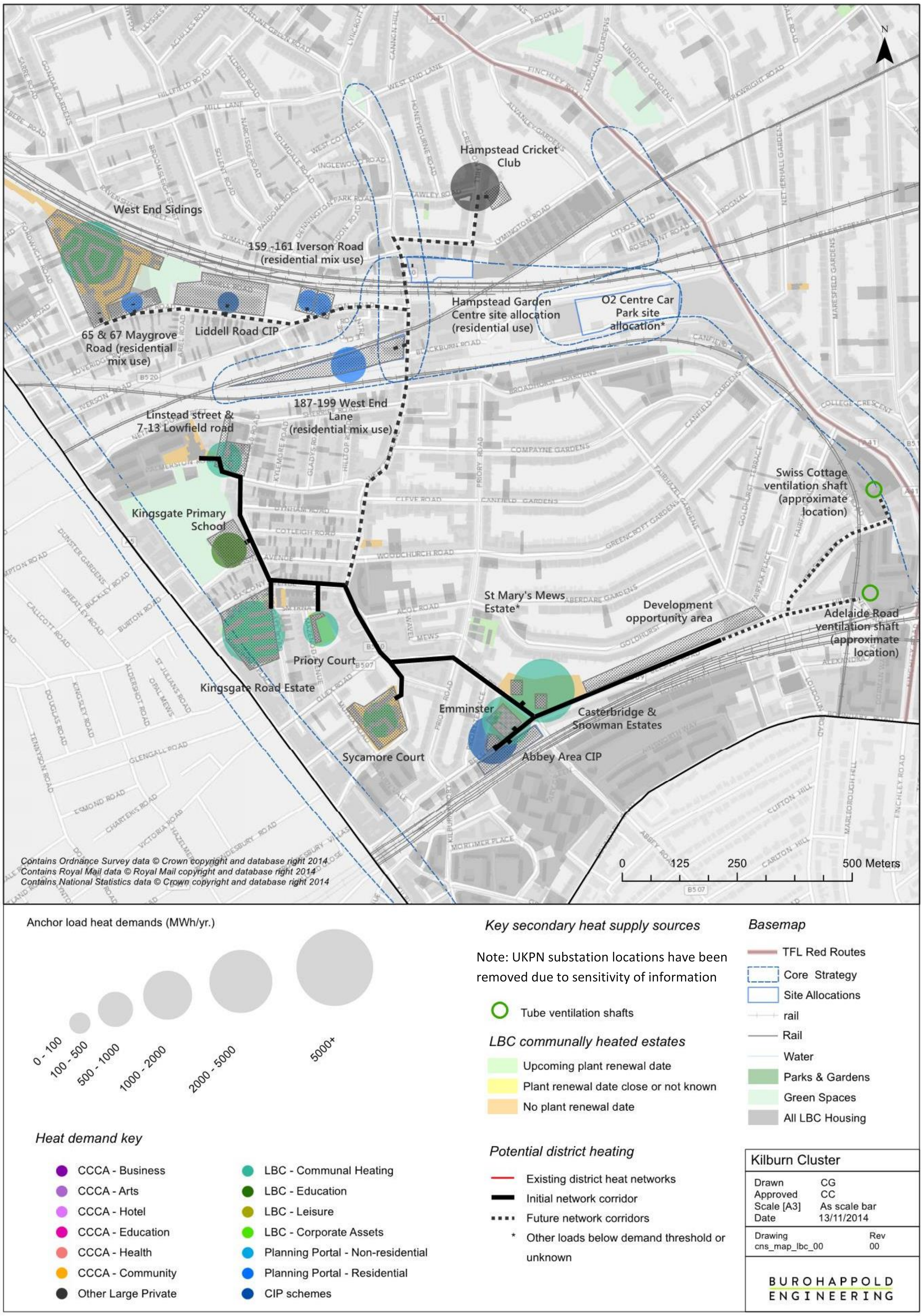


Figure 7—2 Kilburn decentralised energy network cluster

7.2 Kentish Town

Initial Network Corridors

The Kentish Town cluster is an LBC led cluster focused around connecting three communally heated estates, St Silas estate, Denton estate, Harmood Street estate, and Haverstock Secondary School and Kentish Town Sports Centre from a central heat network spine along Prince of Wales Road. All sites on the initial network are existing with two of the three housing estates (Harmood Street and Denton) having upcoming plant renewal dates.

Following a more detailed desktop study of the cluster and discussions with LBC five additional sites along Prince of Wales Road have been highlighted. These were not picked up in the anchor load assessment due to low demands or lack of data but may merit inclusion when considered collectively and connected to the wider cluster. As private developments, discussions with Prince Park and Camden Brewery are recommended as a next step to understand heating systems and to engage with the respective stakeholders. These sites are;

- Talacre Sports Centre - 244 MWh/yr. heating demand is below the anchor load threshold
- Camden Town Brewery - correspondence with the brewery suggests that the site reuses waste heat to minimise demand
- Prince's Park - new residential site. Details of demand and heating system unknown
- Una House - excluded from tier 1 assessment as new boilers installed late 2014/2015, but future potential for DEN connection
- Charlie Ratchford Centre - predicted heat demand of 400MWh/yr. is below tier 1 threshold (500 MWh/yr.)

Future Network Corridors

A number of future network corridors have been suggested in Figure 7—3. The considerations for each are set out below. Each future corridor requires significant additional pipe length. A more detailed assessment is required to prioritise these extensions, which are discussed below.

Northern extension: To the north an extension would connect the communally heated Bassett Street and Cressfield Close estates, with an option to connect to the existing Gospel Oak network.

Western extension: Connection to the redevelopment of Aspen House, a CIP scheme developing 86 new homes. The associated Maitland Park estate has been highlighted as communally heated with an upcoming plant renewal date but has a demand less than the anchor load threshold for connection. A more detailed assessment of the extent of this estate is required to understand this demand, as connection to Aspen House redevelopment alone may not justify the 700m additional pipework required.

South west extension: 800m extension connecting the communally heated Constable House and the Regents Park Road site allocation. Development of the Regents Park Road as part of the Camden Town core strategy area is likely to be required to justify an extension in this area.

South extension: As with the south west extension, this area is dependent on engagement with forthcoming sites, both at the 2-21 Harmood Street (site allocation) and Hawley Wharf (large new mixed use development comprising 8 new buildings to provide employment, housing, retail market and cinema). Early engagement with the Hawley Wharf developers is required to understand the split of tenants and heating systems for this site.

East extension: 650m extension connecting the Castle Road and Durdans house communally heated estates

North east extension: extension connecting projected future loads from two CIP schemes (Gospel Oak Infill and Holmes Road Hostel) and the redevelopment of the Kentish Town Police Station site. As none of these sites are currently developed, there is scope to influence the design of their heating systems however the demands may not be significant to the extent of justifying the network extension (~1,200m).

Secondary Heat Sources

Two secondary heat sources have been highlighted within the cluster area for Kentish Town, these are:

- Kentish Town TFL ventilation shaft: the ventilation shaft is located below the disused South Kentish Town tube station. The site has been converted to retail units and access and ownership of the ventilation shaft is unknown. For these reasons this source has not been considered further at this stage, but could provide an estimated 200 MWh/yr. of secondary heat, 1% of the phase 1 scheme.
- Camden Brewery: the brewing process at Camden Brewery generates waste heat which, given the site's proximity to Prince of Wales Road, could act as a secondary heat supply source for the initial Kentish Town cluster. Correspondence with the brewery has confirmed that all heat produced during the brewing process is recycled on site and as such the Brewery is self-sufficient, with no spare heat for utilisation in a network scheme. There may be opportunities for water heat recovery in the future if the brewery expands, but none are currently identified.

Connection into existing clusters

The Kentish town cluster is located to the south of the existing Gospel Oak network adjacent, which runs south east from the Royal Free Hospital and connects to the Weedington Road estate. The northern extension to the Kentish town cluster could connect in to the Gospel Oak network, creating a network with multiple energy centres. Engagement with the Gospel Oak scheme would be necessary to understand any future expansion plans and existing contract arrangements. Initial engagement with the network operators is key to understand this potential, as it is understood from initial conversations that there may be additional heat available.

Conclusions and recommendations

Phase 1 of the Kentish Town cluster is in the mid-range of the clusters considered in this study, connecting 21,500 MWh/year of heat demand, centred around the St Silas estate, Kentish Town sports centre, Haverstock Secondary School, Denton estate, and Harmood Street estate, with a strong linear heat demand density running along Prince of Wales Road. There are various potential extensions to the north, south, east and west, with the northern extension moving towards the existing Gospel Oak decentralised energy network. To the south, the cluster is constrained by the mainline railway coming in to Euston. The cluster is mainly existing buildings, with three CIP schemes included as potential future network extensions. Secondary heat for this cluster includes the ventilation shaft for the disused South Kentish Town station, for which access and ownership is unknown.

Development of this cluster is subject to a number of deliverability concerns noted in addition to the findings of the technical feasibility study. The following recommendations are set out as key objectives to determine the viability of this network for further consideration:

- Consultation on communally heated estates and Haverstock Secondary school to understand current heating system arrangements and interest in connecting to a DEN

- Determination of timeframe of CIP schemes and potential for DEN future proofing of new developments, in relation to future extensions
- Detailed constraints assessment to validate pipe routes and crossing of railway lines, particularly in relation to legal or cost implications
- Detailed feasibility study of cluster loads including techno-economic assessment

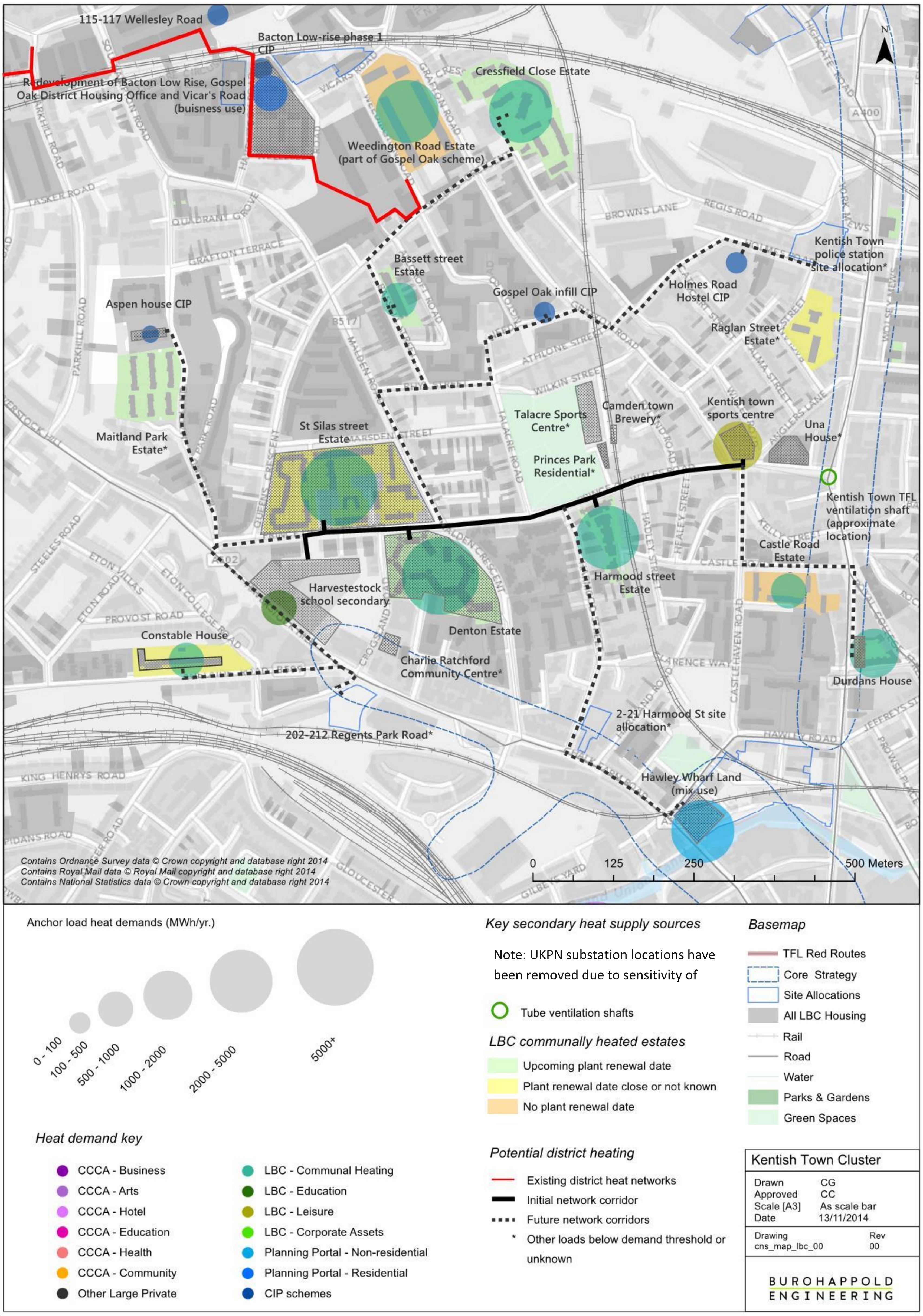


Figure 7—3 Kentish Town decentralised energy network cluster

7.3 South Camden

Initial Network Corridors

The South Camden cluster connects the Curnock Street Estate in the centre of the Borough with other key council owned assets in the area: three CIP sites, the Crowndale Centre (LBC offices) and Cobden House (communally heated LBC housing). Two other non-LBC loads also connect to the initial cluster; 67-72 Plender Street (new build residential) and Greater London House (private offices). Further work is required to understand the heating systems and number of leaseholders at Greater London House; although a large load, the complexity of connecting to multiple third party owners may inhibit the viability of this load.

The initial cluster network is located in an area of many major roads. Although limited in length, multiple crossings of Camden High Street (TFL red route) would be required. Discussions with TFL are required to understand the impact and the degree to which the roads may limit certain buildings being connected to the scheme.

Future Network Corridors

As a standalone network this cluster has a number of constraints, both physical (significant road crossings) and commercial (connection to the multiple occupant Greater London House). As a strategic cluster however, the South Camden cluster is located approximately 500m north west of the Somers Town Energy network and may hold merit as a northern extension to this scheme. In addition the Mayford and Somers Town estates – highlighted for future connection to the Somers Town Energy network are closer, approximately 200m from the southern extent of this cluster. Investigation of the key constraints of the cluster is required to determine the potential for a northern extension to the Somers Town Energy network and the comparative merits over developing the cluster as a standalone scheme.

Opportunities for expansion also exist to the east of the cluster. The future connection loads in this area are made up of a number of site allocations between Camden Street and the Grand Union Canal. There are currently no existing anchor loads in this area and the details of forthcoming buildings are unknown, but sites in this area are in close proximity to each other and the existing network and should be future proofed for an extension in this area. Currently there is no scope to connect this network extension across the Grand Union Canal to the Camley Street cluster as the canal provides a natural physical barrier, however any new bridges developed as part of new development proposals along Camley Street should consider the possibilities of carrying utilities to enable a future link between these clusters.

Secondary Heat Sources

There are no significant secondary heat sources within close proximity to the South Camden cluster. The closest secondary heat sources are the Camden Town TFL ventilation shafts, however connecting these sources to the initial network would require an additional 650m of heating pipe along a major TFL red route road. This site is predicted to generate 400MWh/yr. of heat, 4% of the initial cluster demands. Because of its constraints and limited supply, this source has not been progressed further at this stage.

As part of a wider expansion to include the site allocations to the east of the cluster, the St Pancras substation has been considered. Current estimates from the GLA secondary heat study suggest that this substation could provide 3,300 MWh/yr. of heat (30% of the initial cluster demands). It is understood that UKPN plan to replace these transformers in the near future – consultation with UKPN is recommended to determine whether a waste heat offtake can be factored in to the development of this site.

Connection into existing clusters

The South Camden cluster is physically close to the existing King's Cross DEN and the Somers Town Energy scheme under development. However, the cluster is isolated from the King's Cross DEN by the significant physical barrier of multiple railway lines and the canal, so future connection in this direction is unlikely. Future connectivity with the Somers Town Energy network could be a potential opportunity and warrants further investigation with the developers of this network.

Conclusions and recommendations

Phase 1 of the South Camden cluster is the smallest of the clusters considered in this study, connecting 9,800 MWh/yr. of heat demand, centred around the Curnock Street Estate in the centre of the Borough. The cluster is located between the Somers Town Energy network and new developments along Royal College Street. Connection to either of these developments would be likely to strengthen the case for a DEN in this area, increasing the number of large anchor loads of the scheme.

It is recommended that the eastern extension to connect the Curnock Street Estate to the Royal College Street site allocations is investigated in more detail – currently the progress of these site allocations is unknown. Future proofing these new buildings for DEN, along with the renovations of the St Pancras substation, would boost the viability of the scheme. The electricity substation is one of the largest in the Borough and could act as a key low carbon heat supply source, providing an estimated 3,300 MWh/yr. of waste heat. Connecting this source could provide approximately 30% of the phase 1 heat demands, increasing the scheme's CO_2 emission savings from 1,350tCO_2/yr. to 1,800 tCO_2/yr. by 2050.

Development of this cluster is subject to a number of deliverability concerns noted in addition to the findings of the technical feasibility study. The following recommendations are set out as key objectives to determine the viability of this network for further consideration:

- Consultation with Greater London House landlords to understand heating system arrangements and interest in connecting to a DEN
- Determination of timeframe of CIP schemes and potential for DEN future proofing of new developments
- Determination of timeframe of eastern site allocations and potential for DEN future proofing of new developments
- Consultation with UKPN to understand developments at St Pancras substation and potential for heat recovery
- Detailed feasibility study of cluster loads including techno-economic assessment comparing the scheme as a standalone DEN versus connecting to the Somers Town Energy network, and considering the Royal College Street site allocations and substation
- Detailed constraints assessment to validate pipe routes and cost of crossing Camden High Street (may prohibit connection to Greater London House and Arlington Road demands)

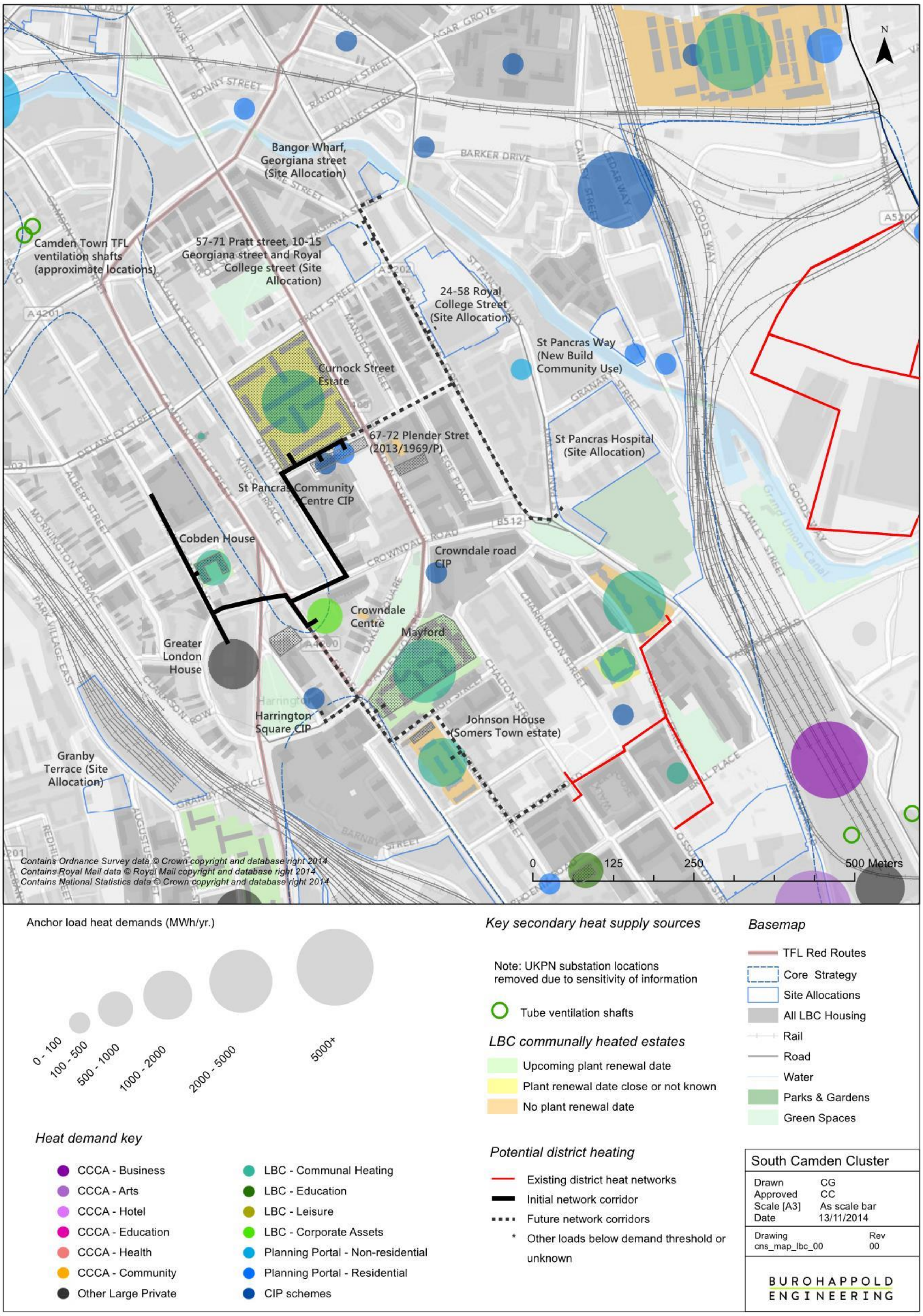


Figure 7—4 South Camden decentralised energy network cluster

7.4 Camley Street

Camley Street is a potential future development area between the St Pancras rail line and the Grand Union canal. The proposal focuses on the prospects for a large mixed use development to the east of Camley Street (labelled Camley Street Corridor sites). Details of these corridor sites are not yet known; the heating demand quoted is based on high level assumptions for the amount of proposed floorspace across new developments in the area.

Initial Network Corridors

The Camley Street corridor sites present an opportunity for a heat network, and are flanked to the north and south with future developments that merit inclusion in a wider district heating network. To the south, 101, 102 and 103 Camley Street have all been granted planning permission for mixed used redevelopment, and construction at 103 Camley Street was recently completed (April 2015). These sites have been future-proofed for connection to a decentralised energy network should one come forward. Both sites will be served by their own CHP system unless plans for a heat network are finalised before they start on site, in which case they will be required to connect straight into it.

To the north there are a further three sites of interest, 120-136 Camley Street, Cedar Way and the Agar Grove Estate. Cedar Way and 120-136 Camley Street currently accommodate light industrial, distribution, storage and other commercial uses, buildings with the potential for development. No current planning applications exist for this site. The Agar Grove Estate is a large housing estate opposite 120-136 Camley Street. The estate is currently made up of individually heated four storey buildings – unsuitable for connection to a district heating scheme without significant building conversion works (likely cost prohibitive). The estate has been granted planning permission for mixed use redevelopment as part of CIP, developing 493 new homes, a large proportion of which will replace existing homes. These new dwellings could be future proofed to allow for connection to a Camley Street network.

Future Network Corridors

The Maiden Lane Estate is a large communally heated estate to the north east of the Camley Street corridor sites. Though geographically close it is separated from the major loads in the cluster by two large railway lines. The only route for DH pipe between the two areas would be ~500m to the north across Agar Grove bridge. As a major load in the area this route merits further investigation however space constraints surrounding the bridge crossing may restrict the connection of these two areas.

A future connection to the existing King's Cross DEN scheme may be possible, subject to an assessment of physical constraints. Currently the only suitable rail crossing point would be along the canal towpath to the south of the cluster.

Key Constraints

The Camley Street cluster is heavily constrained by the rail lines and canal surrounding the cluster. A number of site allocations earmarked for development exist on the southern bank of the canal but have been excluded from this cluster due to the lack of connectivity between sites. These sites may have potential for individual renewable or low carbon energy systems, and any plans for public realm improvements such as a new footbridge across the canal should consider the potential for future district heating connections between this site and the future phases identified in the South Camden cluster.

Connection into existing clusters

The South Camden cluster is physically close to the existing King's Cross DEN and the Somers Town Energy network under development. However, the cluster is isolated due to the physical constraints discussed previously. Connection of this area into other existing clusters is unlikely due to these extensive physical constraints.

Conclusions and recommendations

Should the Camley Street corridor sites be developed this cluster presents a good technical opportunity for a decentralised energy network, given the density and mixed use nature of a new development area. Furthermore the timescale for development sites are such that there is the opportunity to drive the building designs through planning obligations so that they are compatible for connection to a future network. This is a major factor as all other schemes considered in this assessment have some level of building plant room retrofit assumed prior to connection.

The viability of the scheme is reliant on the development of this core Camley Street area as other sites in the area are less suited to connection. With the exception of 101 -103 Camley street (new communally heated residential buildings), the other large loads in the area, notably the Agar Grove estate, would require significant amounts of secondary pipework to connect to a DEN in full. Once a Camley Street corridor network has been established, the benefits of connection may outweigh the cost of these conversions however these sites are not considered primary drivers.

Although central to the Borough, the Camley Street cluster is limited in expansion potential because of the physical constraints of the canal and rail track bounding the east and west of the site. A connection to the existing King's Cross scheme to the west is unlikely given these constraints and other expansion opportunities for this network to connect to large communal heated estates across York Way.

There are no significant secondary heat sources in the area however connection to the South Camden cluster and the associated St Pancras substation could be achieved; this long term vision would connect a number of new loads across the two clusters but relies on a number of developments coming forward and so has not been progressed further at this time.

Dependant on an assessment of the environmental impacts, a water source heat pump could also be considered for this cluster, abstracting heat from Regent's Canal.

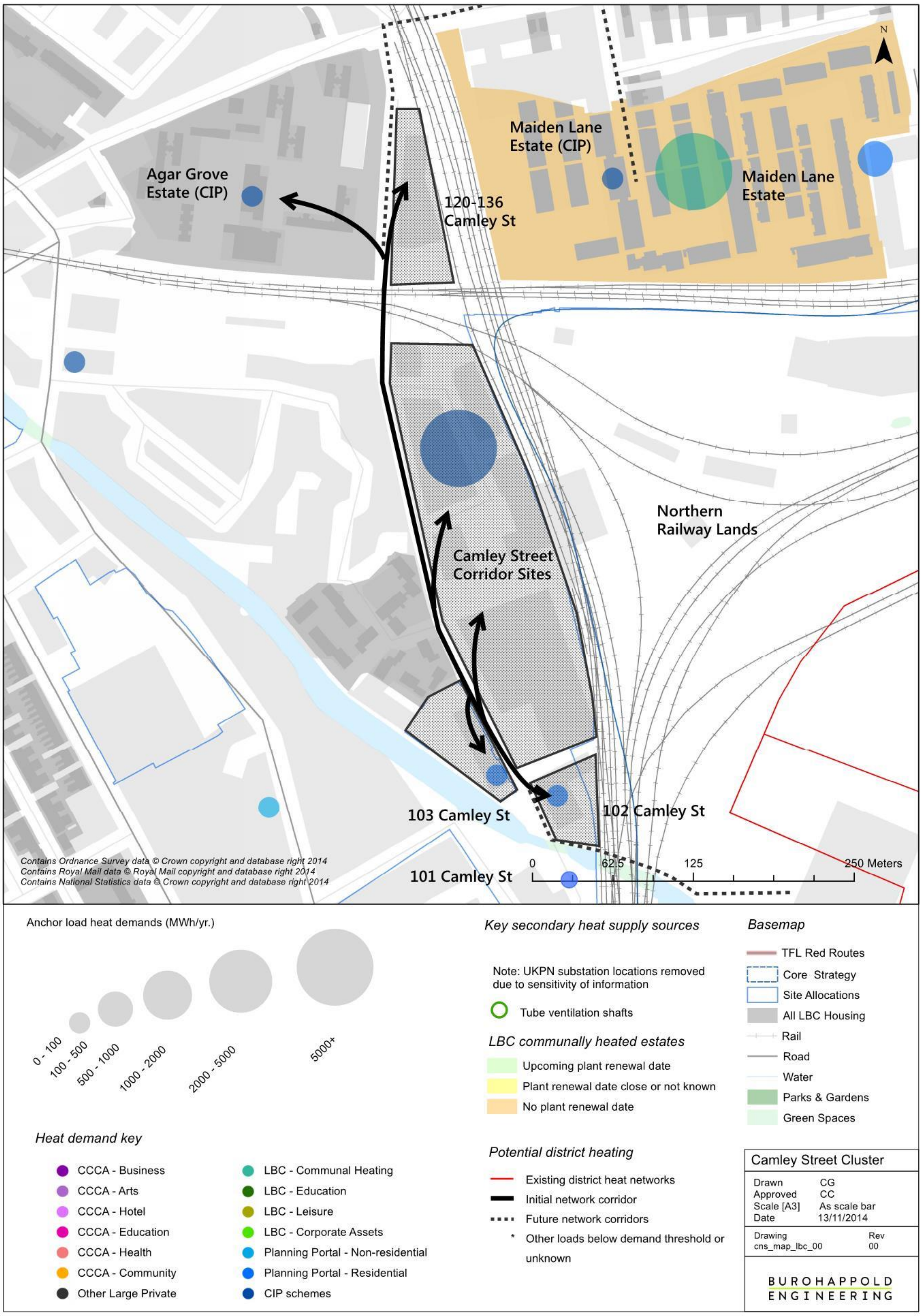


Figure 7—5 Camley Street district energy network cluster

7.5 Russell Square

Russell Square is a cluster of predominantly existing buildings bounded by Euston Road to the north, extending across Gray's Inn Road to the east and southwest to the Brunswick Centre. The loads in this cluster are led by communally heated residential estates and offices.

The area is in close proximity to the existing Bloomsbury and Gower Street networks. Previous analysis has been undertaken on the potential to connect the Brunswick Centre to the existing Bloomsbury network, with the network extending along the northern edge of Russell square, along Bernard Street, and running north along Marchmont Street. It is understood that the Brunswick Centre connection was not considered further in the previous LBC studies due to the complexity around the number of leaseholders in the centre, and a relatively recent upgrade of the heating system. This study was undertaken in 2003 hence there may be merit in revisiting this, however further work is required to understand issues around the heating systems and number of leaseholders as the complexity of connecting to multiple third party owners may inhibit the viability of this load.

Initial Network Corridors

The initial network proposed for Russell Square is to the west of the cluster, starting from Brunswick Centre and running north to connect the Alara UK offices, Hunter House, Aberdeen and Robsart Mansions, Seymour House, Regents Square estate, and Tonbridge House and Hastings House, both part of the Cromer Street estate. It then extends further north to the Camden Council offices, Town Hall extension, and Unison Community Health offices, connecting these from the south side along Bidborough Street, rather than Euston Road to the north.

Future Network Corridors

Future connections extend both to the east and west of the initial network. To the east the network extends from the Regents Square estate past St Peter's Court and the new residential development opposite to the large New Calthorpe Street estate. It also branches north along Gray's Inn Road to pick up the site allocation at 227a Gray's Inn road, and east to Derby Lodge. To the west, extending the network has the potential to pick up secondary heat from the ventilation shaft at Russell Square station. It should be noted that this ventilation shaft location is not known exactly, an indicative location is shown. There may be future potential to link the Russell Square cluster with the Great Ormond Street cluster to the south.

Secondary Heat

The Russell Square tube ventilation shaft has been identified to the west of the cluster; exact location is unknown. Ventilation shafts are a relatively unattractive source of secondary heat; it is estimated that the Russell Square tube ventilation shaft could provide 200 MWh/yr. of heat; 1% of the initial network loads. The tube ventilation shaft is however likely to be close to the initial network (~250m).

Key Constraints

The Russell Square cluster is relatively unconstrained when compared to other clusters, proposed network routes do not extend over major roads such as Euston Road, although Gray's Inn Road is crossed in the future network phases. To reach Derby Lodge which is the tip of the north-east future extension of the network, the network must run along Britannia Road, which bridges over the railway line.

Connection into existing clusters

The Russell Square cluster is adjacent to the existing Bloomsbury Heat and Power network, and is also close to the proposed Great Ormond Street cluster. Should any of these networks expand towards this cluster the loads could be connected into a wider area DEN. There are limited physical barriers in the area, indicating a good level of potential future connectivity. Initial engagement with SOAS, as a key party in the operation of the Bloomsbury Heat and Power network suggests network growth in the immediate future is unlikely due to space constraints for primary plant and limited natural gas supply to the area. Longer term opportunities may exist as the university looks to consolidate plant and reduce CO_2 emissions.

Conclusions and recommendations

Russell Square as a standalone DEN cluster has appeal as the majority of anchor loads are controlled by the Council. As all buildings in this cluster are existing, strategic drivers such as fuel poverty alleviation and CO_2 reduction are increasingly important to justify the works required to allow DEN connection. Notwithstanding these loads, connection to a large single site is preferential to house the scheme energy centre and act as a catalyst for the network development. The Brunswick centre could provide this load, once the existing heating plant is up for renewal. Further work is required to understand this site and the future opportunities. Alternatively, an extension to the existing Bloomsbury Heat and Power network may catalyse the network. Although there are no immediate plans to expand in this area this extension has been investigated previously and could link into new university accommodation also being planned in the south west of the cluster.

It is recommended that this cluster is not progressed currently, but investigated further once more certainty is known either over the future of the Brunswick centre or the future developments of the university's assets in this area.

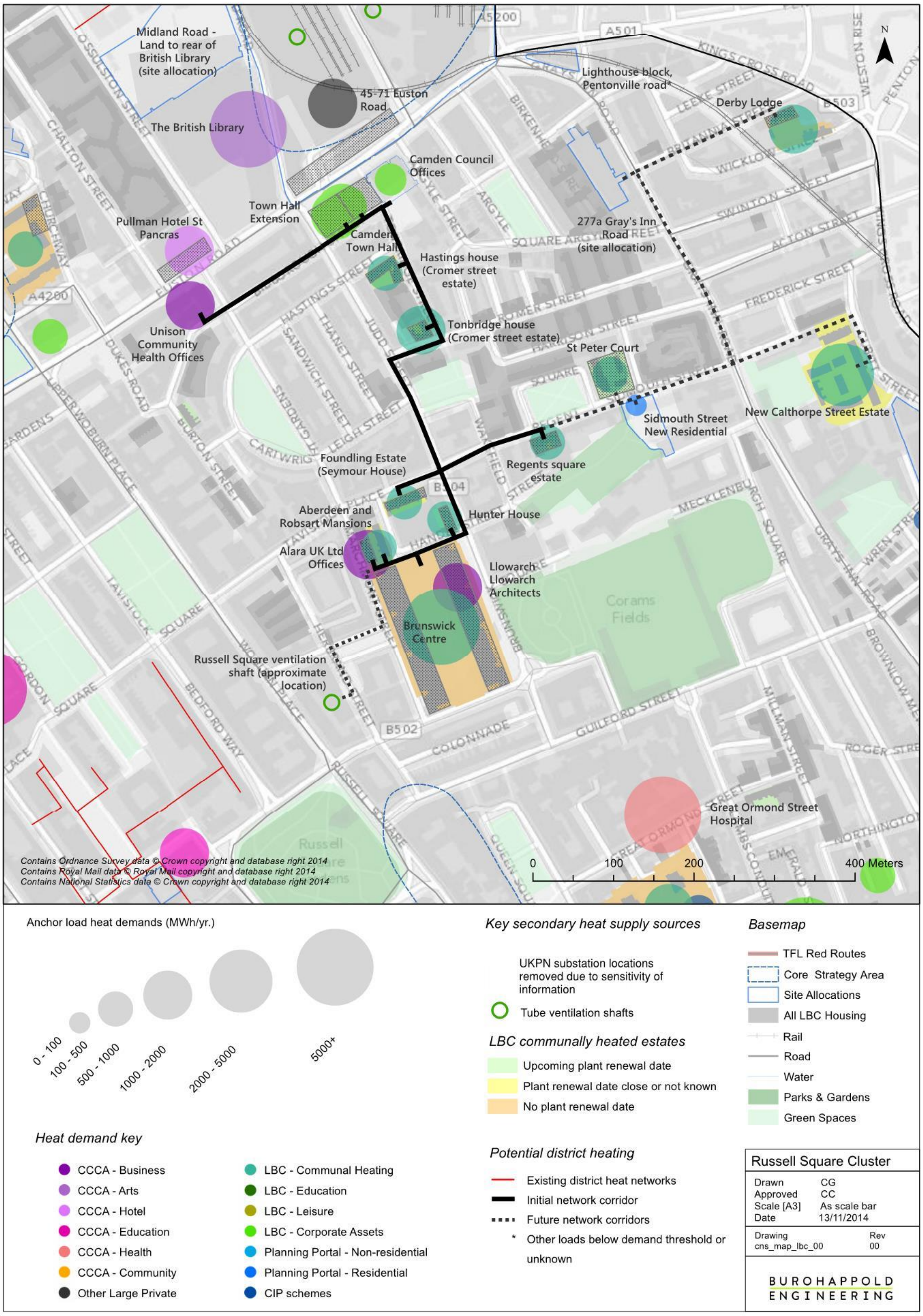


Figure 7—6 Russell Square decentralised energy network cluster

7.6 Great Ormond Street

The Great Ormond Street cluster is a dense initial cluster beginning at Great Ormond Street Hospital and staying within ~400m of the hospital in the initial phase, then extending further east, south and north east in future phases. This cluster incorporates a variety of building types which are predominantly existing buildings with a limited number of site allocations for future development.

Great Ormond Street Hospital is the key anchor load for this cluster; the hospital currently operates a CHP engine and has planned to install two further CHP engines in future development phases. A previous LBC study undertaken reviewed the potential to link GOSH to the Tybalds Estate and concluded that there was not sufficient heat capacity within the current CHP engine or proposed additional CHP engines to export heat. However, a larger CHP engine than currently proposed could be installed and heat exported off-site, provided electricity generated could be utilised. Engagement with Great Ormond Street Hospital is critical for this cluster, to understand the operation of their existing CHP, to understand which buildings are connected to the energy centre and which are not, and the potential to install a larger CHP engine as part of future development proposals. Future development proposals for GOSH are not considered in this modelling, however provide a catalyst for a potential heat network.

Initial Network Corridors

The initial network for Great Ormond Street cluster extends from Great Ormond Street Hospital in the north, runs east along Great Ormond Street and south along Orde Hall Street picking up loads in Chancellors Court and Tybalds Estate CIP, continuing south along Lamb's Conduit Street to connect to the Metropolitan Police Station, and extends east and north to connect to the Cockpit Yard waste management facility. The initial route also extends west along Theobolds Road to connect to Boswell House, on the opposite side of the Tybalds Estate. Further work is required to understand the heat requirements of Great Ormond Street Hospital, and the complexity of their existing heating systems. It is understood that the new and existing buildings on Tybalds Estate are being connected to a centralised heating system through regeneration works, and that Cockpit Yard may be developed in the future.

Future Network Corridors

A number of future network corridors have been suggested in Figure 7—7; each will require significant additional pipe lengths per connection. Future network routes extend out in three arms from the initial network, the first is south to the Fisher Street substation which is a potential secondary heat source, though access is likely to be constrained. The second is south east to the large private load of 2 Waterhouse Square, picking up the site allocation at 50-57 High Holborn on route. The third is north east to Cavendish Mansions residential, the Back Hill UKPN substation (location approximate), and then extending further north to the Phoenix Place site allocation. There may also be future potential to link the Great Ormond Street cluster with the Russell Square cluster to the north, and to pick up UCL buildings such as the Institute of Neurology adjacent to Great Ormond Street Hospital.

Secondary Heat

UKPN have a primary substation (Fisher Street substation) located within this cluster (location is confidential). There is also a ventilation shaft associated with Holborn station close to the substation. Secondary heat from the Fisher Street substation could provide approximately 2,200 MWh/yr. of heat supply to the network, when upgraded to 70°C using 500 MWh/yr. of heat pump energy. This represents 4% of the initial network loads. There is a further UKPN substation located on the north east network extension (Back Hill). Though further from the cluster this substation but may become viable should Cavendish Mansions be connected. Together, this and the Fisher Street substation could provide approximately 7,600 MWh/yr of heat, 15% of the initial network loads.

Connection to the ventilation shaft is less attractive than connection to the Fisher street substation, providing only 200MWh/yr. of heat and requiring the crossing of several major roads to join the cluster, this source has not been considered further in this cluster, in preference of connecting the two substations. There will also be a large Crossrail access and ventilation shaft located in the Fisher street area which is currently under construction, hence has not been included at this stage.

Key Constraints

The Great Ormond Street cluster is relatively unconstrained by physical barriers compared to other clusters, as the proposed network routes do not extend over railway or canals, and use of crossings of major roads is limited. Use of the A401 Theobolds Road as a distribution route for the heat network may create constraints. Future network routes to connect to the Fisher Street substation are likely to be constrained as all roads around this substation are major A-roads. Works relating to Crossrail in the area may also present a constraint in terms of access and timing.

Connection into existing clusters

The Great Ormond Street Cluster is located close to the existing Bloomsbury and Gower Street networks, and the proposed Russell Square network. Should any of these networks expand towards this cluster the loads could be connected into a wider area decentralised energy network. There are limited physical barriers in the area, though some roads such as Southampton Row may present more of a barrier to expansion than others. Initial engagement with SOAS, as a key party in the operation of the Bloomsbury Heat and Power network suggests network growth in the immediate future is unlikely due to space constraints for primary plant and limited natural gas supply to the area.

Conclusions and recommendations

The Great Ormond Street Cluster presents a good opportunity for the integration of the hospital, two large secondary heat sources (UKPN substations) and adjacent LBC estates to establish a future DEN.

The viability of the scheme is reliant on developing a business case to connect the hospital as the key catalyst of the network. The hospital has an existing onsite CHP led network and so two options exist for developing a new network. Either the current scheme is extended with the capacity to serve external loads or the hospital is connected to a new off-site energy centre.

Consultation with the Great Ormond Street Foundation Trust is a priority for this cluster to understand the future energy and carbon drivers of the hospital. Following this a more detailed techno-economic model should be developed to inform a commercial options study looking at ownership options for a future network. This should consider a scheme owned and operated by the hospital, council or third party ESCo as well as a combination of these stakeholders. Lessons should also be drawn from the Gospel Oak scheme. This scheme is existing and has followed the model of connecting an existing hospital to surrounding communally heated estates.

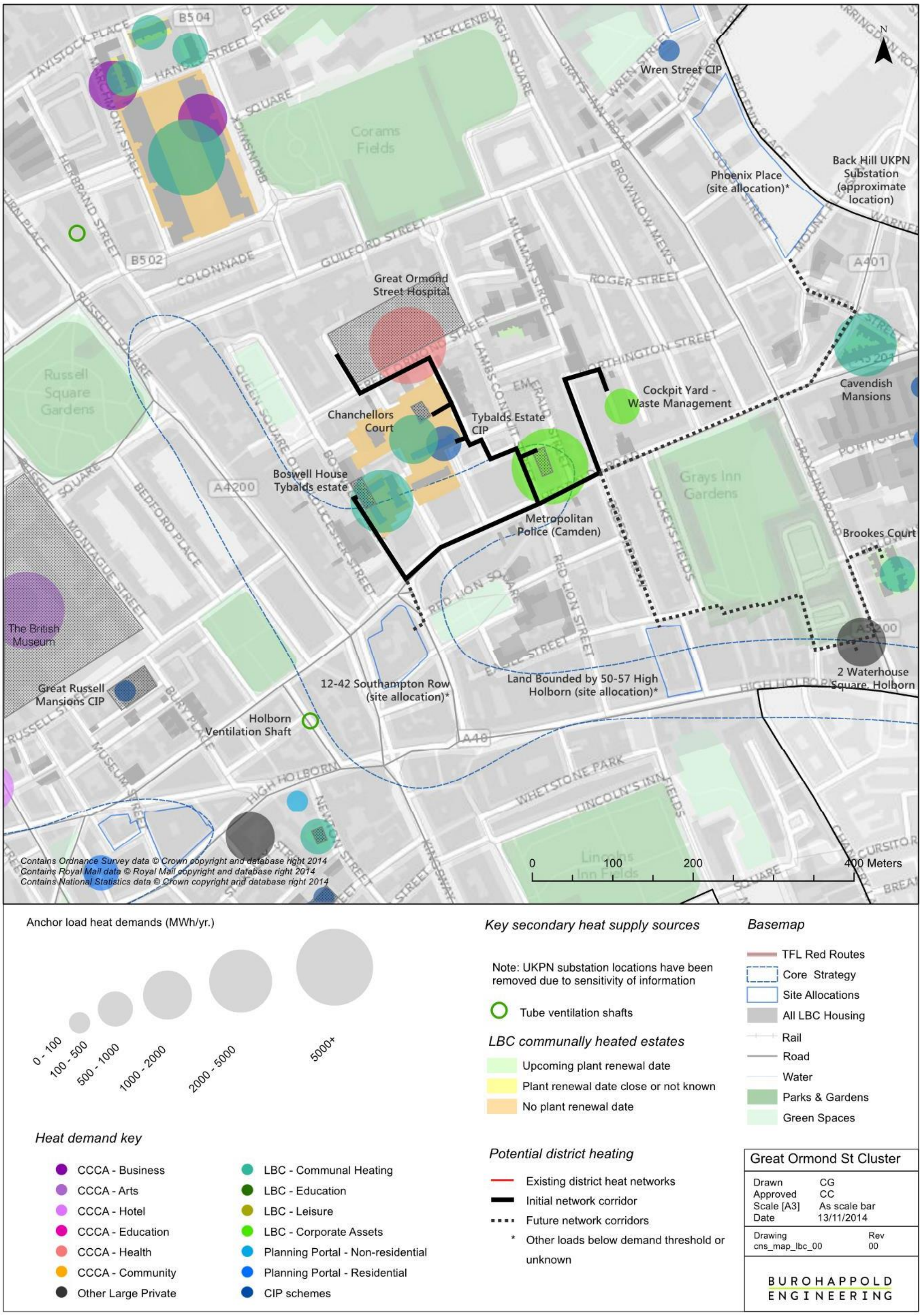


Figure 7—7 Great Ormond Street decentralised energy network cluster

7.7 Decentralised energy network expansion areas

In addition to the six clusters analysed, a number of heat network expansion areas have been reviewed qualitatively. These present opportunities for future expansion, joining smaller schemes to increase resilience and load diversity. Cross-borough expansion areas are discussed where known. These should be considered as long term opportunities, once a core of distinct clusters has been developed.

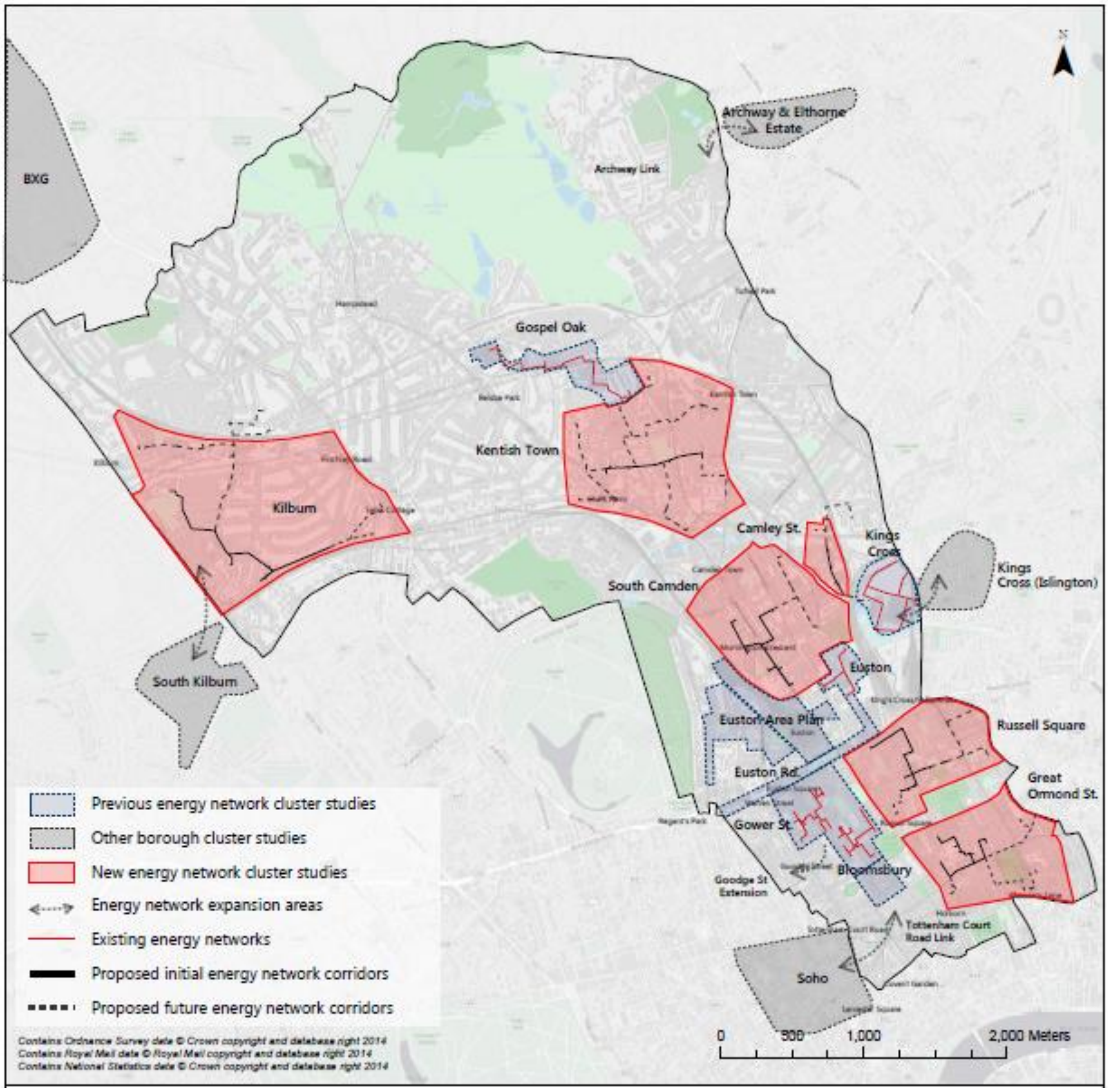


Figure 7—8 Decentralised energy network expansion areas

7.7.1 Existing LBC opportunities

Goodge St

Goodge St has not been considered as a cluster in this study as the area is dominated by private commercial building stock with limited tier 1 loads. Its interest as an expansion area lies in its proximity to the existing university led networks and the high density of site allocations. Progression of this area as a cluster would be heavily reliant on commercial arrangements to engage both forthcoming sites and the existing networks. Connection of these areas would also require a network connection to cross Tottenham Court Road which is a TFL red route.

Tottenham Court Road / Soho

The area to the south of New Oxford Street contains a number of tier 1 anchor loads however these are distributed across this region and without a clear major load with space for locating an energy centre. There is also no clear network route, requiring DH routing along a number of significant roads. This area would become more significant if a Westminster led Soho scheme was forthcoming with the potential to connect to this area together with a long term opportunity to connect further north to the southern clusters in the Borough.

Bloomsbury and Gower Street

The Bloomsbury and Gower Street networks have been considered both previously and as part of this study for connection to anchor loads across Woburn Place, including the Brunswick Centre and Great Ormond Street hospital. Whilst both remain options, this study has focused on treating the Russell Square and GOSH areas as separate clusters, to gauge their potential as standalone clusters. This consideration is in part driven by initial consultation with SOAS (part of the Bloomsbury Heat and Power consortium) suggesting the schemes are open to consideration of expansion but are currently self-sufficient with internal plans for expansion prioritised over connections further afield.

Gospel Oak

As a relatively new scheme, the Gospel Oak network is not an immediate consideration for expansion but has been considered for its proximity to the Kentish Town cluster. A northern extension to the Kentish Town cluster could expand to connect the Cressfield Close estate, passing the existing network adjacent to the Weedington Road estate (part of Gospel Oak scheme). In addition to increasing diversity and resilience by connecting both schemes there may be opportunities for spare heat capacity to be captured at either end of the network, dependant on the capacity of the existing network and the future demands of the Royal Free Hospital and connected housing estates. Further consultation is required to understand the future plans for the Gospel Oak network , and to flag the opportunity for the identified expansion potential.

Somers Town Energy network

The Somers Town Energy network currently under development and planning to connect to the Francis Crick Institute in Phase 2 has potential to expand further north and connect in to the proposed South Camden cluster. As a scheme which is not yet operational it may be prudent to wait to understand the operational performance of the scheme before considering further expansion.

7.8 Cross-borough expansion opportunities

Archway and Elthorne Estate

The Archway cluster in Islington is proposed to link the major loads of the Whittington Hospital and the communally heated Elthorne Estate. Local expansion opportunities are limited and as such cross-borough connection opportunities are of interest. Close to the Borough boundary are several residential loads including Holly Lodge, Makepeace and Langbourne Mansions. Further expansion south east could pick up the Chester Road Estate and a cluster of schools; La Saine Union Convent School, William Ellis Secondary School and Parliament Hill Secondary School. This area has not been investigated as a detailed cluster as the school loads by themselves are not as significant as the other areas investigated. If the Archway cluster should be progressed this area should be investigated in further detail.

South Kilburn

As part of the regeneration of South Kilburn, Brent Council are planning to install a neighbourhood heating system. This scheme is located approximately 750m by road from the proposed Kilburn scheme. The major physical constraint of connecting these schemes is routing heating pipe 180m along Kilburn High Road to cross the east-west railway tracks.

Soho / Tottenham Court Road

The area to the south of New Oxford Street contains a number of tier 1 anchor loads however these are distributed across this region and without a clear major load with space for locating an energy centre. There is also no clear network route, requiring pipework routing along a number of significant roads. This area would become more significant if a Westminster led Soho scheme was forthcoming, with the potential to connect to this area and with a long term opportunity to connect further north to the southern clusters in the Borough.

Kings Cross

The rail and road constraints to the west and south of the existing King's Cross scheme mean that future extensions are more suited to a link to Islington and the Delhi Outram Estate. This option has been studied in further detail in the Islington Borough Energy Mapping report.[13]

[13] *Islington Borough Energy Mapping. Phase 2 Borough Wide Heat Mapping(2014). Available at: http://www.londonheatmap.org.uk/content/borough_heat_map.aspx*

8 Cluster Prioritisation

8.1 Techno-economic assessment

8.1.1 Modelling

The six new clusters identified in Section 7 have been reviewed to assess the outline technical and economic performance of each. Heat demand has been estimated through assigning each building a demand typology, and assigning a relevant heating and hot water demand profile. Indicative heat to power ratios by building typology have been used to estimate an electricity demand for each cluster, and the cumulative heating profile for each cluster used to size indicative energy centre plant. Annual heating profiles per cluster are set out in Appendix E.

Only the initial building connections for each cluster have been included in this technical and economic analysis. Several possibilities for future connections are given in Section 7, of which many are for site allocations where the building demands are not currently known. As such a quantitative assessment of the future loads does not form part of this assessment.

The CHP plant for each cluster has been sized based on achieving 6,000 run hours – within the typical range for optimal performance of such plant. Load duration curves for the six clusters are given in Figure 8—1 below.

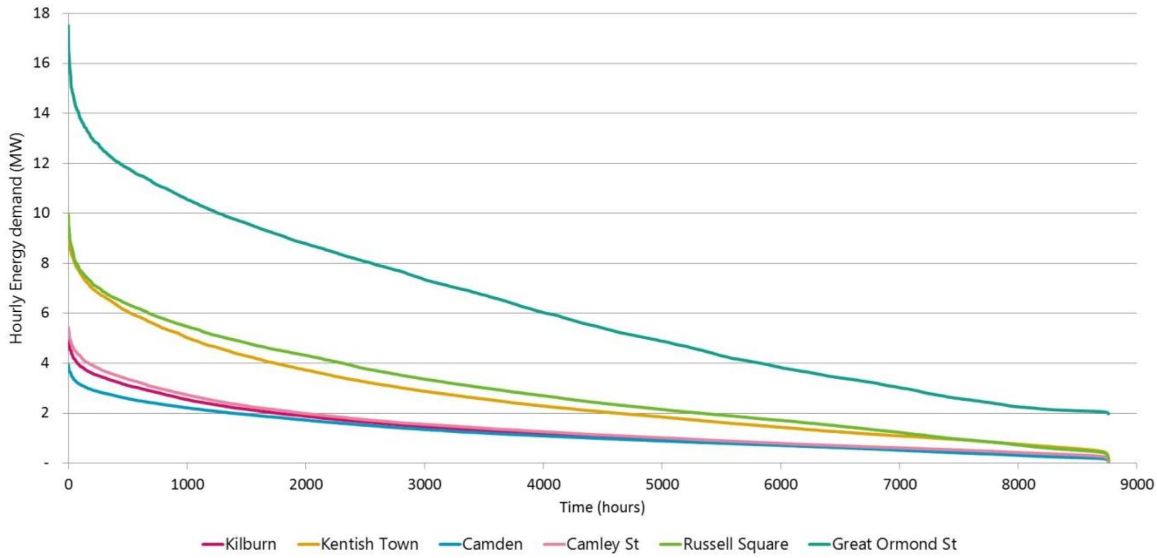


Figure 8—1 Cluster load duration curves

For each cluster capital costing has been undertaken incorporating energy centre plant costs and pipework lengths. The length of trunk heating pipework has been measured, trunk heating pipe sizing has been based on the peak capacity of the initial cluster buildings. An additional length allowance of 20% of trunk network length has been made for smaller diameter pipework, for smaller branch connections to each individual building. Key techno-economic modelling assumptions informing the results are set out in Appendix D.

8.1.2 Results

The clusters offering the best returns are the Great Ormond Street and Kentish Town clusters. Both these clusters have high densities of heating demands with relatively few heat connections for a small length of heating pipe. The Kilburn cluster is the least attractive from a financial standpoint as large lengths of heating pipework are required for a more modest heat demand. It should be noted that these results would change if future expansion loads were considered in the analysis.

The techno-economic assessment shows that all schemes have initial network lengths of a similar order of magnitude. Great Ormond Street has a demand twice that of any other cluster and a small number of building connections as connection to the hospital is considered as a single connection. Factors such as this carry with them risk as the viability of consolidating and connecting the hospital heating plant is unknown prior to engagement with the hospital, and their operation and maintenance schedules may well be planned out and be contractually binding for a number of years.

The impact of connection viability risk across a number of wider factors affecting scheme viability is given in the prioritisation in section 8.2. Carbon savings assume all heat is provided from gas CHP and gas boilers. No secondary heat is included in this assessment, the potential for secondary heat within each cluster is set out in Section 7.

Table 8—1 Technical modelling results by cluster

Cluster	Number of building connections	Trunk network length (m)	Heat demand (MWh/yr.)	Potential for secondary heat supply (MWh/yr.)	Peak boiler capacity (kWth)	CHP capacity (kWth)	Linear heat density (MWh/yr./m)	Potential CO_2 Savings (tCO_2/yr.)
Kilburn	9	1,600	10,900	2,900	6,700	700	7	750
Kentish Town	5	700	21,500	-	13,700	1,400	31	1490
South Camden	8	900	9,800	3,300	6,800	700	11	750
Russell Square	16	1,200	24,000	200	17,300	1,700	20	1800
Great Ormond St.	6	1,000	50,800	7,600	21,900	3,800	51	4070
Camley St	5	800	11,800	-	7,000	800	15	820

Table 8—2 Economic modelling results by cluster

Cluster	Network cost (£m)	Energy centre cost (£m)	Total capital cost (£m)	Energy centre net revenues (£/yr.)	IRR for 25 year scheme (%)
Kilburn	£3,027,000	£986,000	£4,013,000	£309,000	2%
Kentish Town	£1,690,000	£1,973,000	£3,663,000	£610,000	12%
South Camden	£1,720,000	£978,000	£2,698,000	£289,000	6%
Russell Square	£2,752,000	£2,405,000	£5,157,000	£702,000	9%
Great Ormond St.	£2,936,000	£4,434,000	£7,370,000	£1,522,000	15%
Camley Street	£1,500,000	£1,056,000	£2,556,000	£336,000	9%

8.2 Identifying priority clusters

There are multiple criteria which can be used in prioritising a pipeline of clusters to develop as part of LBC's heat network vision. A weighted matrix has been developed together with LBC and used to factor in additional constraints, using scores of 0 to 4 to allow each criterion to be assessed in parallel. A list of criteria and scoring guide for this analysis is given below in Table 8—3. This score weighting can be changed dependent on the importance of drivers; two differing scenarios have been considered.

Table 8—3 Cluster prioritisation criteria

Criteria	Unit	Score				
		0	1	2	3	4
Meeting Camden's Objectives						
Carbon Saving	Reduction in CO_2 emissions (tonnes per year)	< 0.5	0.5-1.0	1.0-1.5	1.5-2.0	> 2.0
Potential Fuel Poverty Impact	Average proportion of households in the cluster LSOA that were fuel poor	<0	0-5%	5-10%	10-15%	15%+
Financial Considerations						
IRR	%	< 5%	5 - 10%	10 - 15%	15 - 20%	> 20%
Deliverability						
Energy demands	Linear heat density of phase 1 loads (MWh/m)	<10	<20	<30	<40	<50
Heat source availability	Qualitative assessment based on potential of secondary and renewable heat to power identified clusters and heat supply from existing schemes	Standalone gas led CHP required only.	Existing gas boiler plant for peak supply.	Future potential for integration of secondary/ renewable sources	Potential case for integration of secondary/ renewable sources	Strong case for integration of secondary/ renewable sources.

Physical constraints	Qualitative based on number of road / rail / river crossings	Major physical constraint affecting scheme viability	Major road, rail or utilities crossing(s)	Minor road rail or utilities crossing(s), mostly 3rd party land	Minor road rail or utilities crossing(s), mostly LBI land	Majority of network developed in backstreets, minimal ownership issues
Space Constraints	Qualitative based on the available nearby space to house plant required to support energy network	On site plant space not available for use. No off site space.	On site plant space not available for use. Off site space limited.	On site plant space not available for use. Off site space identified.	On site plant space requiring expansion.	On site plant space available for use.
Organisations involved	Qualitative assessment based on the number and nature (public/private) of organisations in the cluster	Several sites owned by SMEs	1 site owned by private developer/ social housing provider	>1 site owned by private developer/ social housing provider	1 site owned by large public organisation/ LBC	>1 site owned by large public organisation/ LBC
Timing	Qualitative assessment based on pending redevelopment plans and heating system replacement programme.	No sites with heating system replacement in next 5 years.	1 sites with heating system replacement in next 5 years.	2 sites with heating system replacement in next 5 years.	3 sites with heating system replacement in next 5 years.	>3 sites with heating system replacement in next 5 years.
Contribution Towards Long Term Strategy						
Regeneration Area Proximity	Cluster located in close proximity to forthcoming LDF growth areas, CIP schemes and major planning applications.	No regeneration areas in cluster	Future potential to connect to regeneration areas	Regeneration schemes part of cluster	Regeneration schemes part of cluster and future expansion	Regeneration led cluster
Enabling of a Borough wide vision	Number of adjacent strategic vision clusters/existing energy networks for direct connection	0	1	2	3	>3

To assess the sensitivity of the prioritisation to the drivers, two scenarios have been developed, one being led by LBC drivers and the other focused on investment drivers. The weightings of the drivers have been adjusted accordingly for each scenario. Cluster scorings and the weightings of each category are shown in Table 8—4 below.

Table 8—4 Cluster prioritisation scenarios and weighting

	Cluster prioritisation scores						Scenario weighting	
Prioritisation category	Kilburn	Kentish Town	Camden	Camley St	Russell Square	Great Ormond St	LBC led scenario	Investment led scenario
Carbon Saving	1	2	1	1	3	4	10%	5%
Potential Fuel Poverty Impact	2	2	3	1	3	2	5%	0%
IRR	1	3	2	2	2	4	20%	30%
Energy Demand Density	1	4	1	1	2	4	5%	5%
Heat Source Availability	2	1	2	1	2	3	5%	5%

Physical Constraints	3	3	0	3	2	2		7.5%	10%
Space Constraints	2	2	2	4	2	2		5%	10%
Organisations Involved	2	4	4	2	3	4		15%	15%
Timing	2	3	2	0	3	0		10%	15%
Regeneration Area Proximity	3	1	3	4	0	1		15%	5%
Enabling of Borough Wide Vision	1	1	3	2	1	1		2.5%	0%

Table 8—5 below shows the order of prioritisation of the clusters according to the two scenarios. The scenario testing demonstrates some variation in cluster prioritisation depending on the weighting of the key drivers. The best performing clusters are consistently Great Ormond Street and Kentish Town. It should be noted that there is currently no weighting factor in place to allow for the complexity of connection for large complex loads such as Great Ormond Street Hospital, or the reliance on one body to commit to driving a scheme. Changing the scenario weighting has an impact on the top four clusters as the difference between them is marginal in the prioritisation matrix, Camley Street and Kilburn are unaffected by this shift in prioritisation.

Clusters that do not perform highly in the prioritisation have merits in other areas. Camley Street is an example of a cluster which cannot be fully developed now but may become a priority cluster in the future as a large scheme – it scores highly on the enabling of a Borough wide vision, developing a regeneration area and accommodating an energy centre.

Table 8—5 Cluster prioritisation results

Priority	Camden led	Investment led
1	Great Ormond St	Kentish Town
2	Kentish Town	Great Ormond St
3	Camden	Russell Square
4	Russell Square	Camden
5	Camley St	Camley St
6	Kilburn	Kilburn

8.3 Comparison with existing clusters

The assessment carried out in section 8 is used for a comparative cluster assessment only. The financial performance of each cluster is indicative and reliant on a number of technical and economic assumptions. For existing clusters the information to populate these fields is not available in the public domain and as such a robust comparative assessment is not possible. A comparison can be made on the key technical parameters, set out in Table 8—6 below. The annual heat demand for existing schemes has been estimated from previous demand estimates from DeMap studies or from assumed plant run hours where the installed heating plant is known. Network lengths are estimated from a review of as-built drawings.

Table 8—6 Technical comparison against existing clusters

Cluster	Number of primary heat exchanger connections	Primary network length (m)	Estimated heat demand (MWh/yr.)	Linear heat density (MWh/yr./m)
Kilburn	9	1,600	10,900	7
Kentish Town	5	700	21,500	43
South Camden	8	900	9,800	11
Russell Square	16	1,200	24,000	20
Great Ormond Street	6	1,000	50,800	51
Camley Street	5	800	11,800	15
Gospel Oak	**6**	**1,500**	**15,200**	**10**
Gower Street Network	**11**	**1,800**	**9,600**	**5**
Bloomsbury Heat and Power Network	**21**	**2,500**	**18,300**	**7**
Kings Cross Network	**17**	**2,000**	**43,300**	**22**
Somers Town Energy network (Phase 1)	**7**	**500**	**16,600**	**31**

Table 8—6 demonstrates that the six new clusters assessed in section 7 are of a similar magnitude both in heat demand, number of buildings and heat demand density as the existing clusters of the Borough. Kentish Town has the largest heat demand density by virtue of all phase 1 building connections being located on a single road, this is in comparison with the Bloomsbury and Gower Street networks, where the cross-campus connections require further pipework – justified as this pipe is of a lower cost; primarily in soft landscaping connecting to buildings of a fewer stakeholders. This observation highlights the importance of commercial and practical considerations for decentralised energy network design – the technical performance of the six new networks are all within the range of values given for the existing schemes.

9 Report Recommendations

LBC may wish to further develop a Borough wide vision for decentralised energy which consolidates the various sets of analysis undertaken to date, reviews financial and commercial aspects of existing successful clusters, and prioritises clusters to be brought forward as well as potential connections between clusters. This must be aligned with development plans for the Borough, with the long-term goal of delivering a Borough wide decentralised energy network in the future. This should be broken down into short, medium and long-term tasks and goals. The cluster prioritisation matrix developed for this study can be adapted or built upon in order to develop a deeper understanding of the importance and influence of each criteria in successfully bringing forward energy networks.

As part of LBC's existing Heat Network Delivery Unit funding, three clusters are being taken forward for further detailed analysis during the current financial year. These are:

- Kentish Town West
- Somers Town Energy – Network Expansion
- Bloomsbury

This study has reconfirmed the suitability of these three clusters. It is recommended that alongside the techno-economic and masterplanning works proposed for these clusters, stakeholder engagement and review of DEN delivery models is undertaken. For other clusters identified as suitable through this study, and appropriately prioritised, further analysis which should be carried out includes:

- Stakeholder engagement, which is critical in order to understand the likelihood of developing a successful scheme, and to understand any barriers to networks which can be softened or removed
- Analysis of the technical, cost and delivery implications around connecting energy networks into complex existing sites, such as Great Ormond Street Hospital, which cannot be fully understood without a thorough understanding of existing building stock and mechanical systems
- Review of LBC's programme of retrofit of communal heating systems into existing individually heated multi-residential buildings, to understand if there are any opportunities to add additional loads into existing clusters
- Further technical analysis around energy centres, design and space requirement
- Secondary heat analysis for relevant clusters, including engaging with TFL / UKPN as relevant, and refining the heat availability from secondary heat sources
- Further financial analysis around investment criteria and funding sources, including establishing viability criteria to be used for evaluating scheme performance
- Review of successful delivery models for decentralised energy networks and their appropriateness for each cluster to be taken forward for further analysis

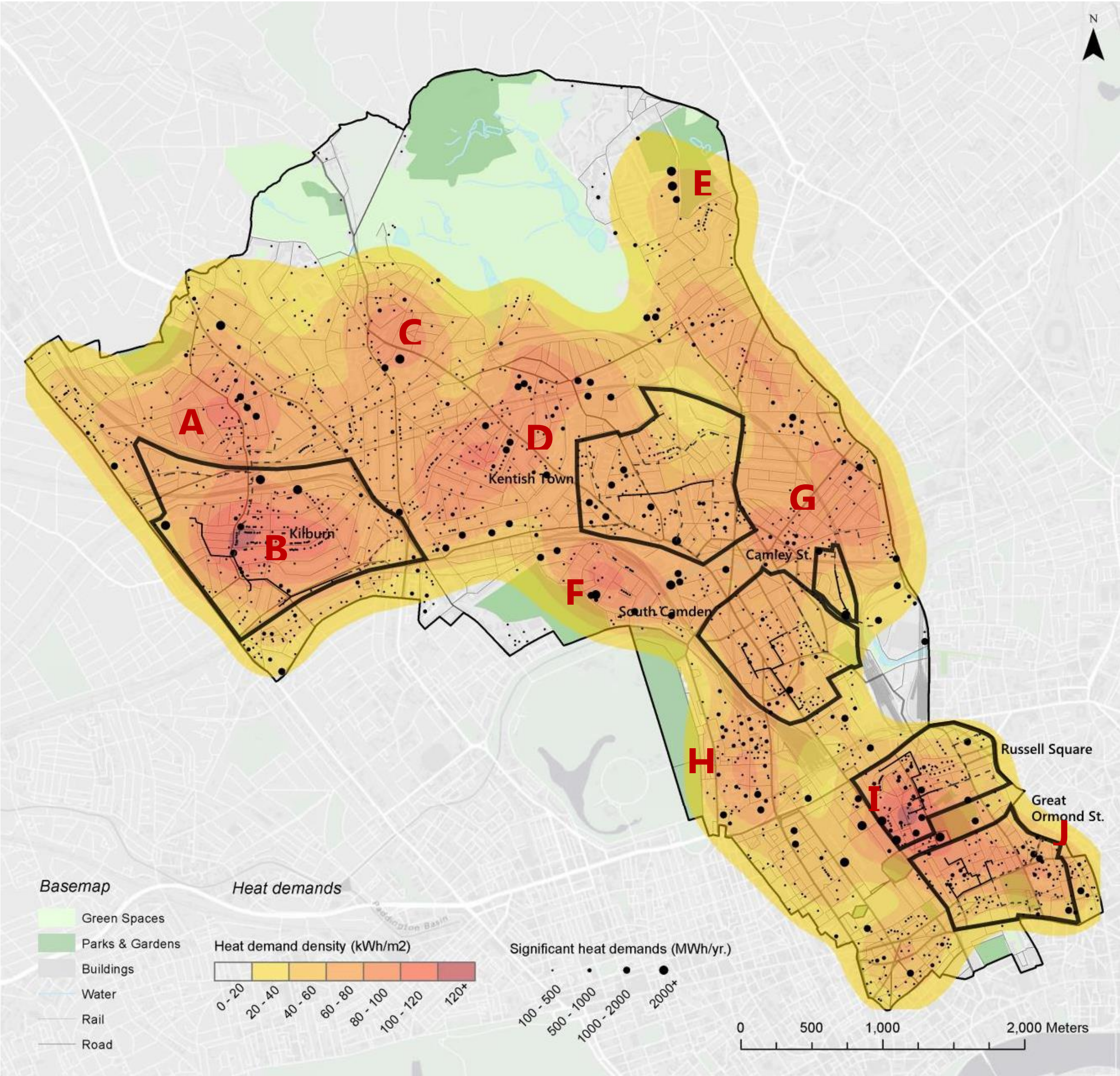
LBC should also look to further engage with surrounding Boroughs on the three highlighted cross-borough opportunities, to undertake similar analysis as set out previously for clusters which fall entirely within LBC. LBC may also wish to consider the potential for future decarbonisation of decentralised energy networks, moving away from natural gas as the primary fuel source.

Appendix A Tier 2 and 3 demands

Decentralised energy network (DEN) clusters in this assessment are based on the tier 1 loads. This refined list removes the majority of heating demands to filter those most suitable for connection to DENs. The two key initial bulk domestic and non-domestic databases are presented for reference below, to discuss expansion potential to tier 2 and 3 buildings once initial networks are established.

Domestic

The map below shows the total density of all domestic heat demands across the Borough. The density layer is the total heat demand, with significant heat demands (over 100MWh/yr.) picked out as individual points.



LBC domestic heat demand

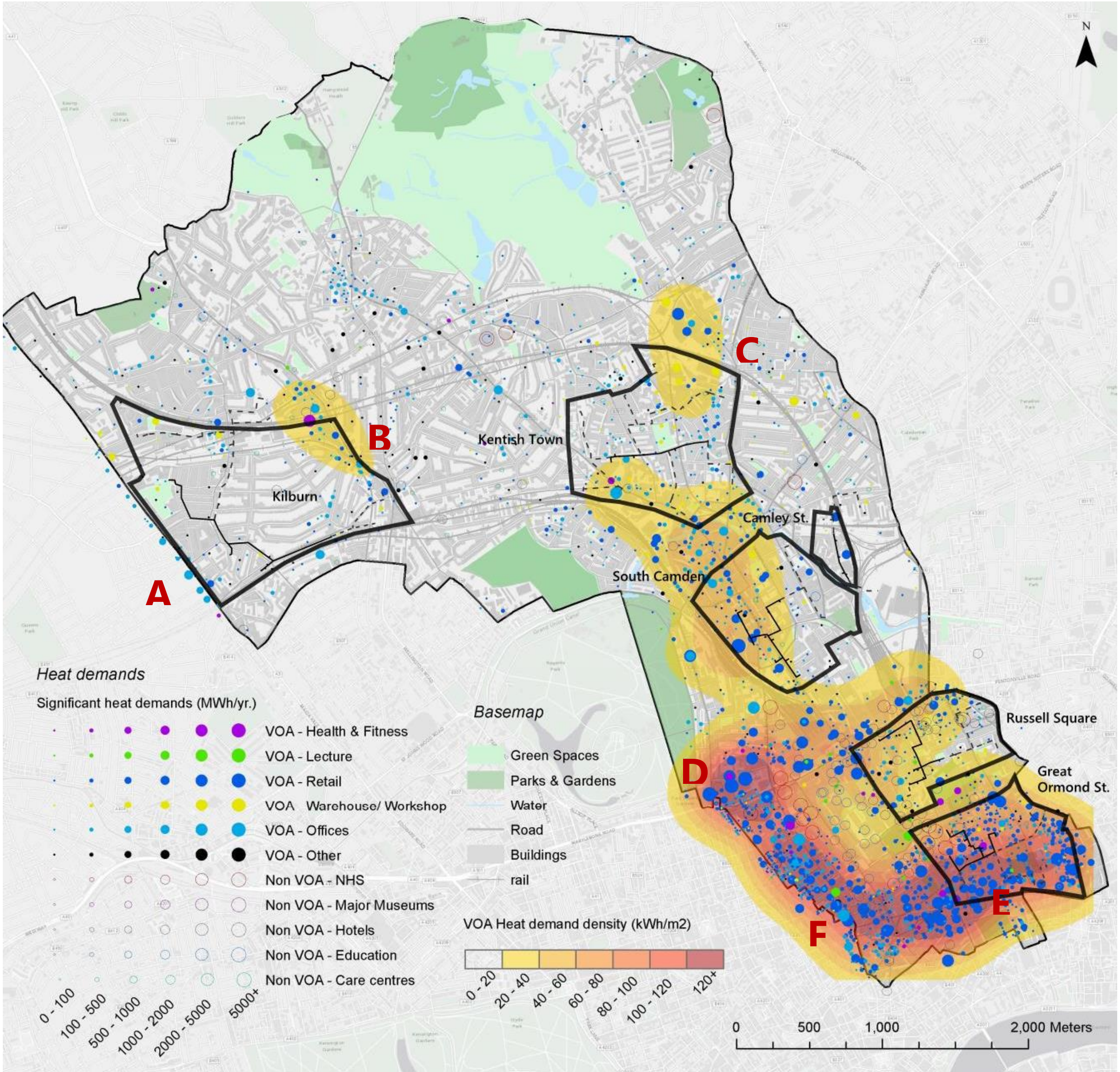
This domestic map shows the key areas across the Borough with high residential heat demands and their relationship to the six clusters discussed in this report. Large loads not picked up in the tier 1 database are primarily private individually heated apartment blocks. These were excluded from tier 1 as to connect to these buildings would require expensive heating system conversion works. These buildings remain of interest where they are located in proximity to clusters, as once a network is established, building conversion as part of future refurbishment works could become a viable solution.

LBC domestic hubs

Map Ref	Name	Description
A	Finchley Rd	Predominantly low rise individual buildings. High heat demand density between Finchley Rd and West Hampstead centred around the 19th century Harvard Court, Yale Court and Marlborough Mansions. These 4 storey mansion blocks are likely individually heated and although of high density would require significant retrofit for connection to a network.
B	Swiss Cottage	High heat demand density in residential areas either side of West End Ln. Predominantly low rise terraced housing with the exception of Embassy house and Sydney Boyd Court Independent student living apartments (north of cluster)
C	Hampstead	Residential area with two large significant loads; Greenhill and Henderson court. These blocks s in close proximity to each other and adjacent to North Bridge House Senior School.
D	Belsize Park	Large number of significant domestic loads, possibility for trunk DH spine along Haverstock Hill. Large terraced residential loads between Haverstock hill and the B517. East-west train line could constrain extent of network. 3 large residential towers adjacent to the Royal Free Hospital; Cayford house and Coppetts Wood house and Princess Cristian house.
E	Highgate Hill	Holly Lodge, Makepeace and Langbourne Mansions. Large mansion blocks with high heat demand however area entirely residential, less favourable for DEN than areas of mixed use demands.
F	West Camden	Oldfield Estate (Jacqueline House, Marion House, Carole House). 7 storey council owned residential properties on the edge of primrose hill. Predominantly residential area.
G	Camden Road	Number of medium density estates including Inward Court, Soane Court and Woollett Court. Also the Lulworth tower block which forms part of the Agar Estates regeneration proposals.
H	Regents Park	Residential area to the east of Regent’s Park including Schafer House, The White House, Mackworth and Harrington House. Potential to link to Regent’s Place or Netley network.
I	Russell Square	High heat demand density centred around the Brunswick centre. Housing is a Grade II listed and so heating conversion may not be possible. Surrounding area also includes large residential blocks such as International Hall and Russell court,
J	Farringdon	Distributed residential area near Farringdon including Cavendish Mansions, Vesage Court, Mullen Towers, and Bourne Estate. Potential future extension to the Great Ormond Street cluster.

Non –domestic

The map below shows the spatial distribution of all heat demands predicted using the VOA database. This database has a focus on office and retail uses and does not include public sector buildings such as hospitals and universities. These public sector buildings been included at an indicative scale in the key but their demands are not included in the heat density overlay.



LBC non-domestic heat demand

This map clearly shows the abundance of office and retail spaces in the south of the Borough. As with domestic tier 2 and 3 loads, it cannot be known at this stage whether the building heating systems of these buildings would be suitable for connection to DENs however a number of areas merit consideration for future cluster studies.

A: Kilburn High Road

Kilburn High Road has a high linear density of heat demands running along the road, some of which fall into Camden and some into the adjacent London Borough of Brent. The majority are office and retail. This area could be of interest due to the linear nature, however the costs and impact of disruption along this road could be significant.

B: Finchley Road

The area around Finchley Road includes several large VOA loads including health and fitness, office, and retail. Some non-VOA heat demands are also located in this area. This area is relatively constrained by multiple road and rail lines, including the A41.

C: Tufnell Park

To the south west of Tufnell Park station is an area with office and retail VOA loads, with further retail along Highgate Road. This area is constrained in all directions other than east by railway lines, hence opportunities to connect through to Gospel Oak are likely to be limited.

D: Regent's Place

Regent's Place is an area of known high heat demands on and around the British Land owned site. The VOA data highlights a number of retail spaces in this area, plus some health and fitness spaces. British Land have previously investigated the potential for district energy in this area, and have highlighted the complexities around changing existing building heating systems. This area has potential to connect to the Netley network.

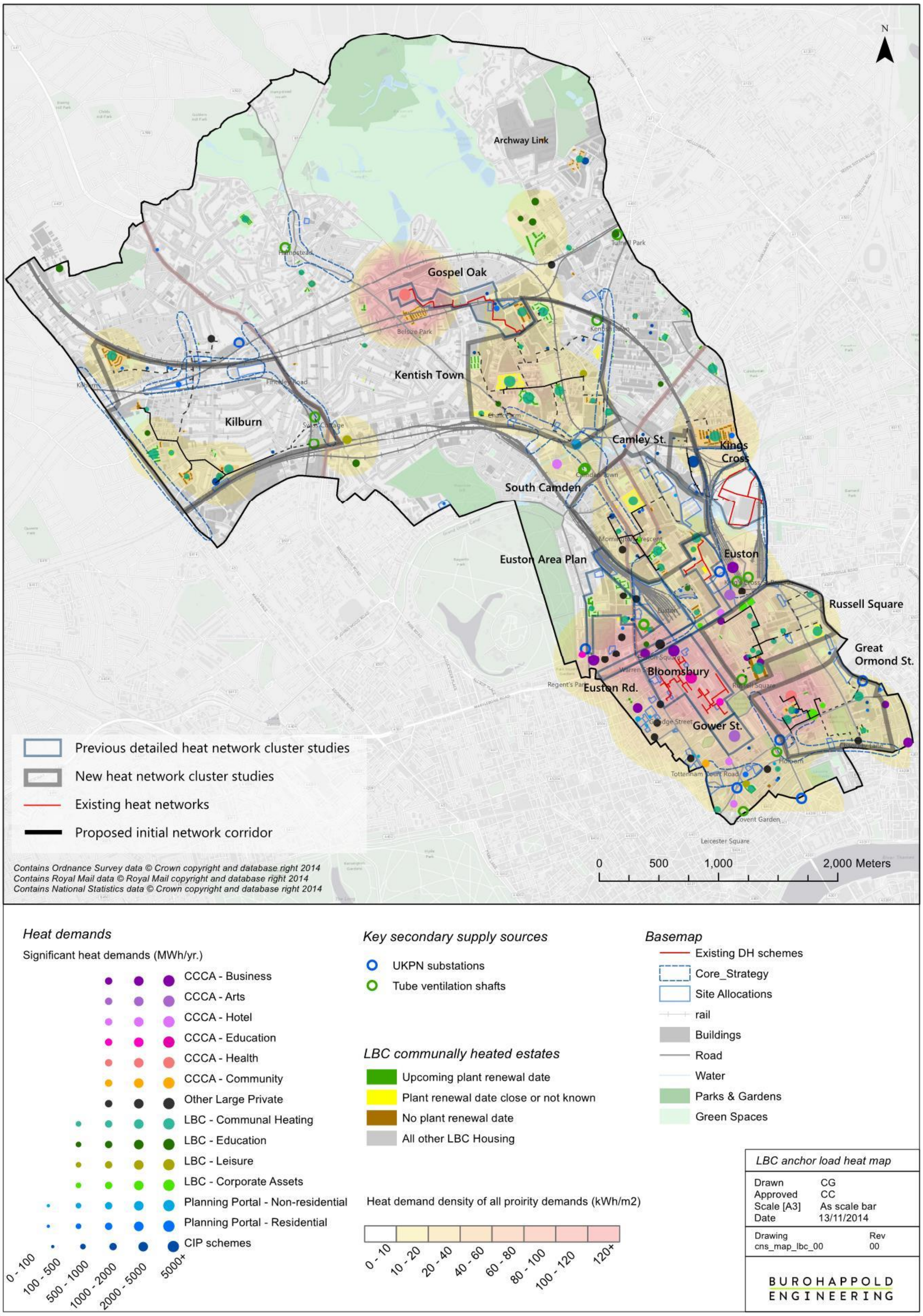
E: Theobalds Road

Theobalds Road and New Oxford Street are areas of high density of VOA properties, predominantly office and retail. There is potential to link this cluster as an extension of the Great Ormond Street cluster, or to independently network this area in a number of ways; though there is likely to be difficulty in finding space for an energy centre in this southern end of the Borough.

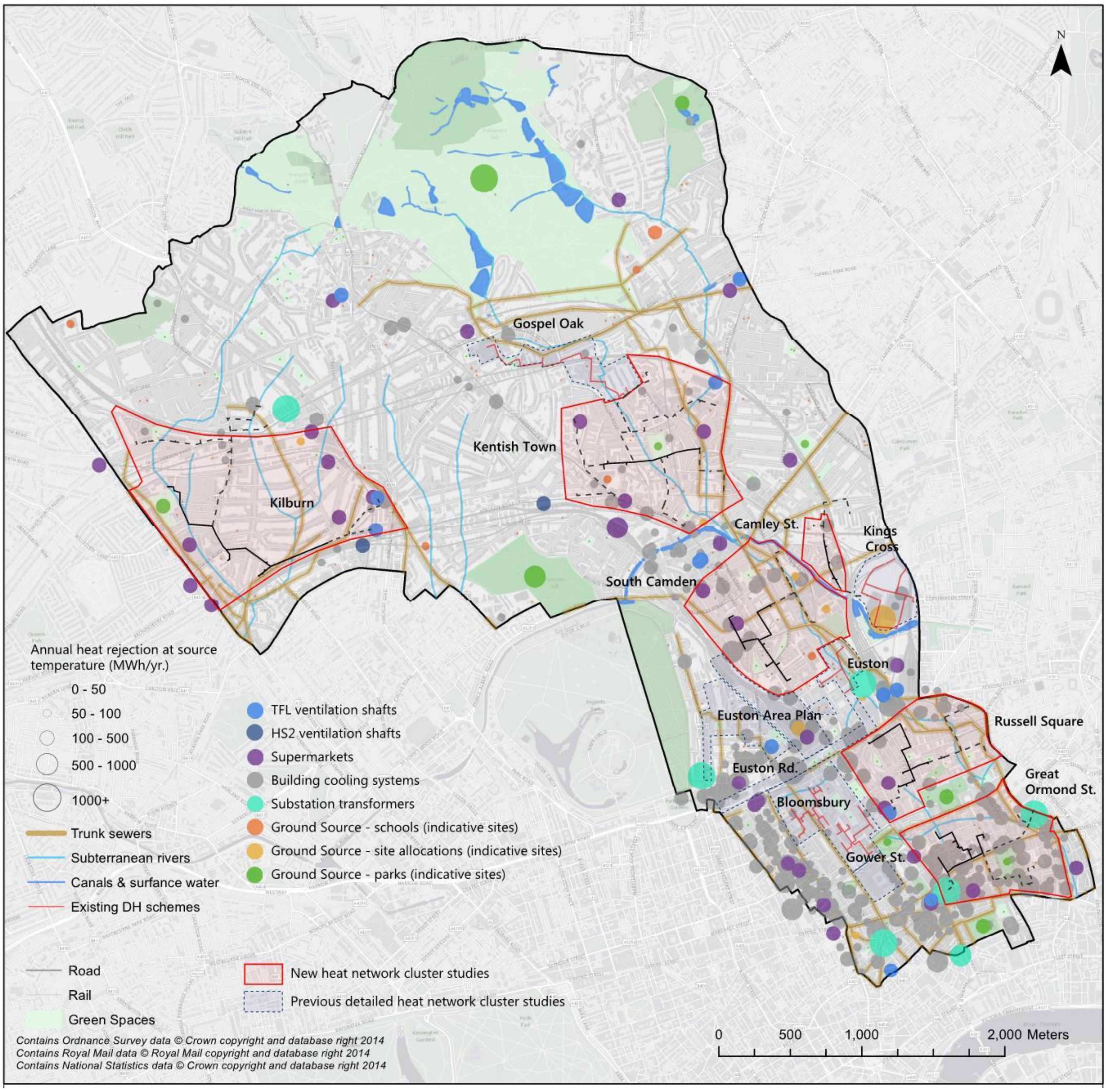
F: Tottenham Court Road

Tottenham Court Road represents an area with a high density of demand for retail and office space. There is potential to link this area in any number of ways; though there is likely to be difficulty in finding space for an energy centre in this area.

Appendix B Cluster overlay maps



Heat demand cluster overlay map



Secondary heat supply cluster overlay map

Appendix C Building energy benchmarks

Existing building benchmarks

Existing building energy demands have been benchmarked based on CIBSE Guide F Energy Benchmarks assuming all heat is supplied by gas boilers with a gross fuel conversion efficiency of 80%.

Existing building heating benchmarks

Building Category	Predicted heat demand (kWh/m^2/year)	Predicted electrical demand (kWh/m^2/year)	Predicted cooling/ refrigeration demand (kWh/m^2/year)
Offices (CIBSE Guide F type 1-3)	92*	112*	31
Offices (CIBSE Guide F type 4)	92*	112*	41
Retail (average across typologies)	118	280	86
Banks and building societies	63	71	18
Community centres	125	22	18
Distribution and storage	80	20	-
Fitness centre	201	127	
General manufacturing	125	50	
GP surgery / dental practice	174	33	
Lecture room, arts	100	67	
Light manufacturing	90	31	
Post offices	140	45	
Primary education	113	22	18
Restaurants (with bar)	1,100	650	
Social clubs	140	60	
Supermarkets	200	915	
Department Store	194	237	
Hotel (TM46)	330	105	92
Hospital (teaching hospital)	338	86	
Sport hall	103	39	
DIY store	127	149	

*averaged across all office types

New building benchmarks

New building benchmarks are used to estimate the heat demand of planned new developments, where only floor area data is available. Where residential unit numbers only are given, a floor area of 70m^2 has been assumed based on the average of typical small and large apartment sizes[14].

[14] http://www.zerocarbonhub.org/sites/default/files/resources/reports/Fabric_Energy_Efficiency_for_Zero_Carbon_Homes-A_Flexible_Performance_Standard_for_2016.pdf

New building benchmarks

Typology	Heating	Cooling (thermal)	Benchmark reference
	(KWh / m²/yr.)		
Business	8	-	Part L 2010 compliance model for predicted office heating assuming 25% improvement
Apartments	46	-	Part L 2010 SAP compliance model for small apartment
Townhouses	46	8	Part L 2010 SAP compliance model for mid-terrace house
Leisure	82	26	Part L 2010 compliance model for multi-use mall
Retail	27	10	Part L 2010 compliance model for multi-use mall
School	35	3	Part L 2010 compliance model for secondary school
Hotels	154	25	Part L 2010 compliance model for hotel (including A/C)
Hospital	159	5	CIBSE Guide F with 50% notional reduction to heating benchmarks
Community	29	-	Averaged load based on education and leisure benchmarks

Appendix D Techno-economic modelling assumptions

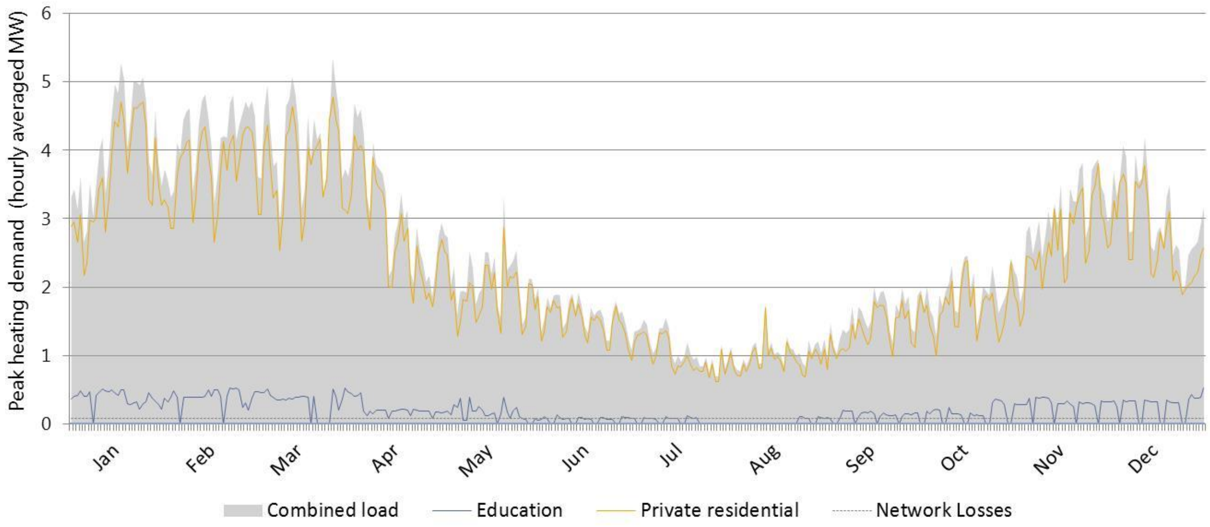
Techno-economic modelling assumptions

Cost	Unit	Value
Heating trunk pipe unit cost	£/m	1,700 – 2,500 (dependent on pipe sizing which is based on heat demand)
Heating branch pipe unit cost	£/m	600
HIU at building connections	£/MWh/yr. heat sales	3.8
Energy centre gas boiler cost	£/kW	35
Energy centre CHP cost	£/kWth	500
Heating sales	£/MWh/yr. (inclusive of standing charges)	55
Heat production cost	£/MWh heat supply (weighted averaged between CHP and boilers)	34
CHP electricity sales (average grid spill)	£/MWh	35
Energy centre O&M cost	%/yr. of energy centre capex	2%

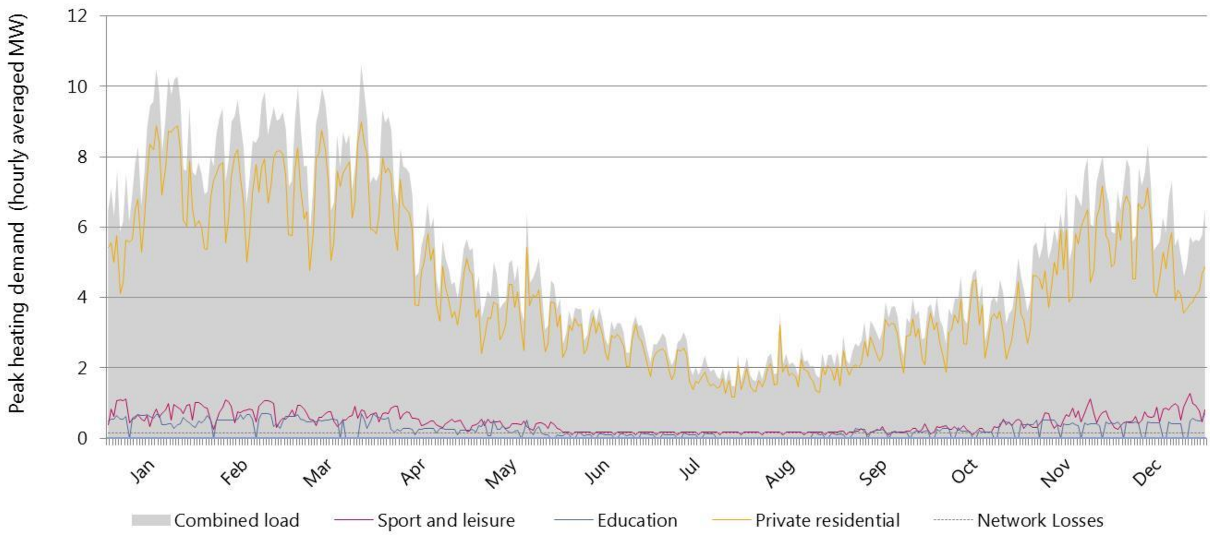
Capital costs

	DH network costs			Energy centre costs				
	Pipe network	HIU cost	Total network cost	Boiler plant cost	CHP cost	Additional plant costs	Prelims - overheads & contingency	Total energy centre cost
Kilburn	£ 2,958,000	£ 69,000	£3,027,000	£ 235,000	£ 382,000	£ 431,000	£ 370,000	£ 1,418,000
Kentish Town	£ 1,566,300	£ 124,000	£1,690,300	£ 480,000	£ 753,000	£ 863,000	£ 740,000	£ 2,836,000
South Camden	£ 1,649,900	£ 70,000	£1,719,900	£ 238,000	£ 373,000	£ 428,000	£ 367,000	£ 1,406,000
Russell Square	£ 2,600,100	£ 152,000	£2,752,100	£ 606,000	£ 898,000	£ 1,052,000	£ 902,000	£ 3,458,000
Great Ormond Street	£ 2,747,800	£ 188,000	£2,935,800	£ 767,000	£ 2,005,000	£ 1,940,000	£ 1,663,000	£ 6,375,000
Camley Street	£ 1,428,200	£ 72,000	£1,500,200	£ 245,000	£ 415,000	£ 462,000	£ 396,000	£ 1,518,000

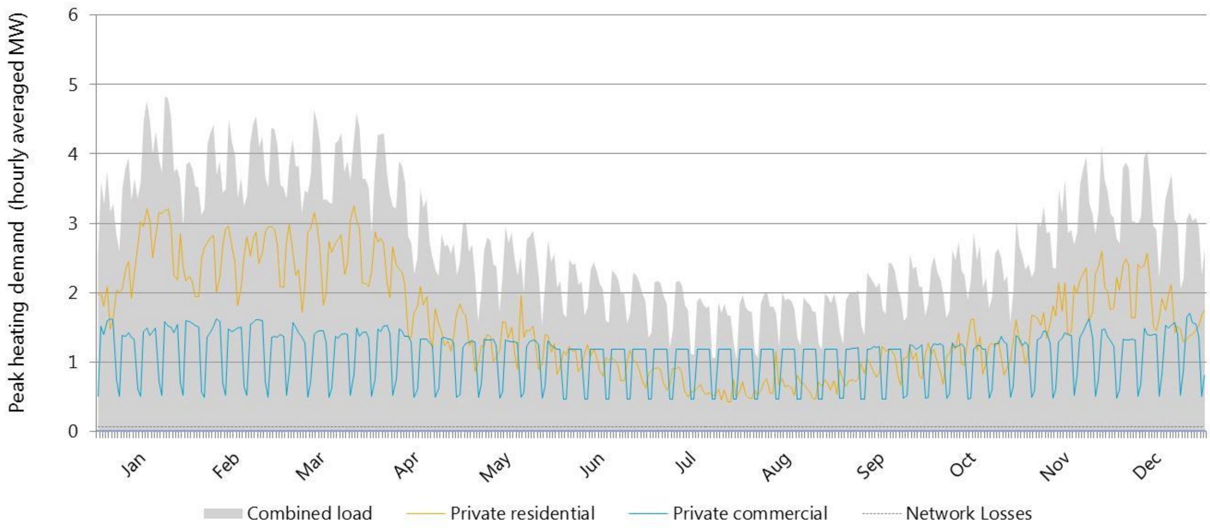
Appendix E Cluster heating demand profiles



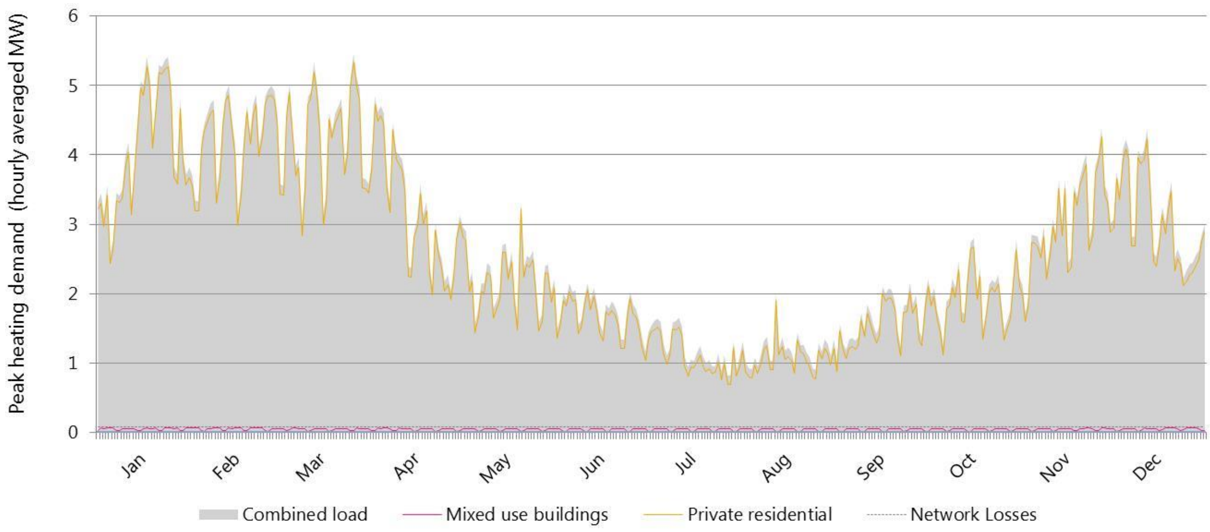
Kilburn phase 1 heating profile



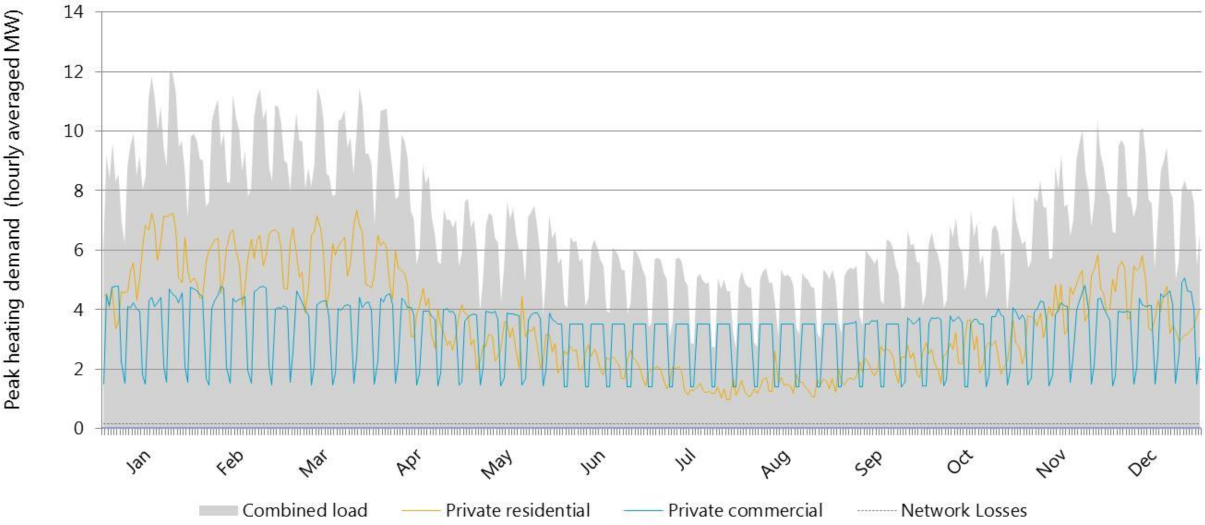
Kentish Town phase 1 heating profile



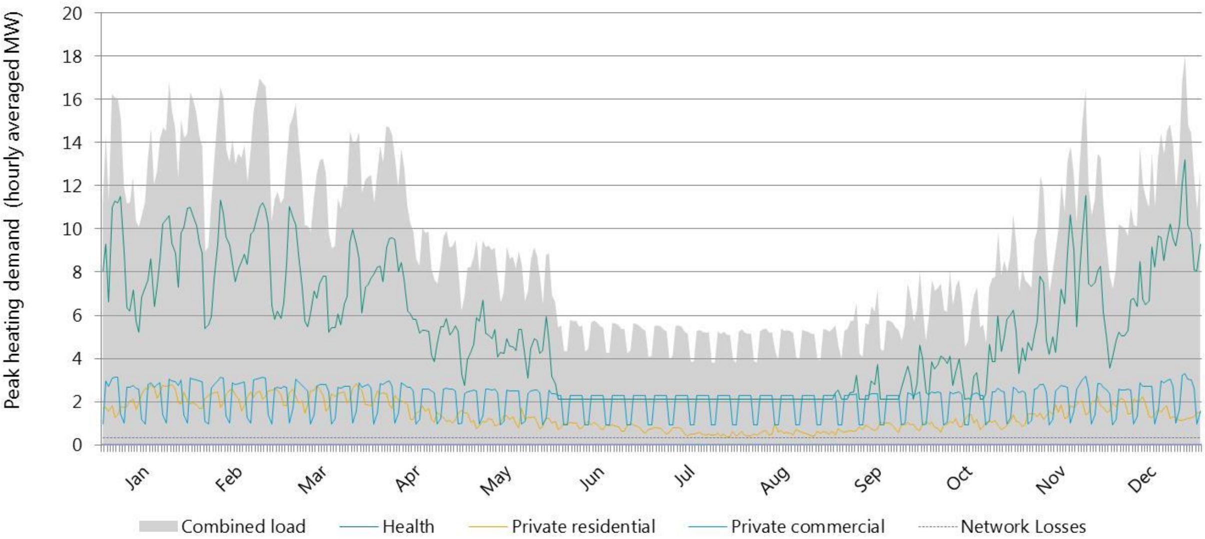
South Camden phase 1 heating profile



Camley Street phase 1 heating profile



Russell Square phase 1 heating profile



Great Ormond Street phase 1 heating profile

Appendix F Cluster Heat Demands

Initial Cluster Loads

Cluster	Building	Typology	Heat demand (MWh/yr.)
South Camden	67-72 Plender Stret (2013/1969/P)	Planning - Residential	200
South Camden	St Pancras Community Centre CIP	CIP	400
South Camden	Crowndale Centre	LBC Corporate	800
South Camden	COBDEN HOUSE	Communal heated estate (type A)	900
South Camden	Carreras Cigarette Factory	VOA - Offices	1,100
South Camden	Curnock Street Estate	Communal heated estate (type B)	4,900
Camley St	2011/1586/P - Erection of part 6, 7, 8 and 10 storey building comprising 3,877 sqm builders merchant and 563 student bed spaces with ancillary student facilities. *Note – this may have been completed.*	Planning - Mixed Use	100
Camley St	2011/5695/P - erection of a building ranging from 4-12 storeys to create a mixed use development	Planning - Residential	200
Camley St	2014/4381/P - redevelopment for a mixed use building ranging from 8-12 storeys	Planning - Residential	200
Camley St	Camley Street development area	Planning - Residential	11,200
Great Ormond St	COCKPIT YARD - WASTE MANAGEMENT	LBC Corporate	600
Great Ormond St	Tybalds Estate	CIP	600
Great Ormond St	CHANCELLORS COURT	Communal heated estate (type C)	1,900
Great Ormond St	BOSWELL HOUSE TYBALDS ESTATE	Communal heated estate (type C)	3,700
Great Ormond St	Metropolitan Police (Camden)	LBC Corporate	4,600
Great Ormond St	Great Ormond Street Hospital	CCCA - Health	39,500
Kentish Town	HAVERSTOCK SCHOOL SECONDARY	LBC Education	700
Kentish Town	Kentish town sports centre	LBC Leisure	1,200
Kentish Town	HARMOOD STREET ESTATE	Communal heated estate (type A)	3,500
Kentish Town	DENTON CHP SITE	Communal heated estate (type A)	5,000
Kentish Town	ST SILAS STREET ESTATE	Communal heated estate (type B)	11,100
Kilburn	SYCAMORE COURT	Communal heated estate (type C)	500
Kilburn	KINGSGATE PRIMARY SCHOOL	LBC Education	500
Kilburn	LINSTEAD STREET & 7-13 LOWFIELD ROAD	Communal heated estate (type A)	600
Kilburn	PRIORY COURT	Communal heated estate (type B)	700
Kilburn	Abbey Area – Phase 1 2 & 3(Car Park, Health Centre, Hinstock & Eminster)	CIP	1,200
Kilburn	EMMINSTER	Communal heated estate (type C)	1,600
Kilburn	CASTERBRIDGE & SNOWMAN	Communal heated estate (type C)	2,400
Kilburn	QUEENSGATE (KINGSGATE ROAD ESTATE)	Communal heated estate (type A)	3,100
Russell Square	Sidmouth Street New Residential (2011/0503/P)	Planning - Residential	200
Russell Square	HUNTER HOUSE	Communal heated estate (type A)	500
Russell Square	ABERDEEN MANSIONS	Communal heated estate (type B)	600
Russell Square	ST PETERS COURT	Communal heated estate (type A)	700
Russell Square	HASTINGS HOUSE CROMER STREET ESTATE	Communal heated estate (type B)	700
Russell Square	FOUNDLING ESTATE (SEYMOUR HOUSE)	Communal heated estate (type B)	800

Russell Square	REGENTS SQUARE ESTATE	Communal heated estate (type C)	1,000
Russell Square	TONBRIDGE HOUSE (CROMER STREET ESTATE)	Communal heated estate (type B)	1,200
Russell Square	CAMDEN TOWN HALL	LBC Corporate	1,200
Russell Square	Llowarch Llowarch Architects	CCCA - Business	1,200
Russell Square	Alara UK Ltd	CCCA - Business	1,300
Russell Square	TOWN HALL EXTENSION	LBC Corporate	1,400
Russell Square	Unison Community Health Offices (& 2011/4653/P)	CCCA - Business	1,400
Russell Square	Camden Council Offices	CCCA - Business	1,500
Russell Square	New Calthorpe Street Estate	Communal heated estate (type B)	3,000
Russell Square	BRUNSWICK CENTRE	Communal heated estate (type C)	7,200

Future Potential Known Cluster Loads

Cluster	Building	Typology	Heat demand (MWh/yr.)
Great Ormond St	Brookes Court	Communal heated estate (type A)	600
Great Ormond St	2 Waterhouse Square, Holborn	VOA - Offices	1,000
Great Ormond St	Cavendish Mansions	Communal heated estate (type A)	2,200
Kentish Town	Gospel Oak Infill	CIP	200
Kentish Town	Holmes Road Hostel CIP	CIP	400
Kentish Town	Aspen house CIP	CIP	500
Kentish Town	CASTLE ROAD ESTATE	Communal heated estate (type C)	600
Kentish Town	Castle Road Estate	Communal heated estate (type C)	600
Kentish Town	BASSETT STREET ESTATE	Communal heated estate (type A)	700
Kentish Town	Constable House	Communal heated estate (type B)	800
Kentish Town	Durdans House	Communal heated estate (type A)	1,500
Kentish Town	CRESSFIELD CLOSE	Communal heated estate (type A)	2,000
Kentish Town	Hawley Wharf Land (2012/4628/P)	Planning - Mixed use	2,300
Kilburn	Hampstead Garden Centre (2012/0099/P)	Planning - Mixed use	100
Kilburn	159 -161 Iverson Road (2014/5341/P)	Planning - Mixed use	100
Kilburn	Liddell Road	CIP	100
Kilburn	65 & 67 Maygrove Road (2012/5934/P)	Planning - Mixed use	300
Kilburn	187-199 West End Lane (residential mix use)	Planning - Mixed use	700
Kilburn	Hampstead Cricket Club	VOA - Retail	1,500
Kilburn	WEST END SIDINGS	Communal heated estate (type C)	4,200
Russell Square	Derby Lodge	Communal heated estate (type C)	1,100

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