AECOM

Hounslow HMMP Report

Heat Mapping & Masterplanning

London Borough of Hounslow

Project number: 60678525

1st September 2022

Delivering a better world

Quality information

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Revision History

Revision	Revision date	Details	Authorized	Name	Position
1	01/09/22	First Issue	TR	Tristram Royce	Principal Consultant
2	26/09/22	Second Issue	TR	Tristram Royce	Principal Consultant

Distribution List

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Definitions

Term	Definition
Counterfactual	The alternative technology that a heat customer would employ should they not connect to a heat network. In this study, to align with the GHNF, the counterfactual for domestic customers is gas boilers and for non-domestic customers is air source heat pumps.
Heat Tariff	The cost to customers for heat from the network. In this study, this tariff is based on the customers avoided cost of the counterfactual and is inclusive of both standing and variable charge.
Base Case	Technoeconomic analysis based on initial stated parameters.
Scenario	Technoeconomic analysis with stated adjustments to specific Base Case parameters. All parameters not mentioned remain as per the Base Case.
Levelised Cost of Heat (LCoH)	Levelised Cost of Heat is a metric that allows for the comparison between schemes/projects considering of all component costs required to deliver heat to customers. In this study, it is assessed over a 40-year lifespan and an annual 3.5% discount is applied to ‘levelise’ the future cost to today’s value. The LCoH of a network can be compared to the counterfactual, or to other networks, to demonstrate its value in terms of heat delivered
Internal Rate of Return (IRR)	In this context the IRR is a measure of the underlying return the district energy network owner expects to achieve by investing in the project excluding cost of financing. Fundamentally, the IRR is the constant interest rate at which a given series of cash outflows must be invested for an investor to earn a given series of cash inflows as income. All IRR’s in this report are 40-year pre-tax values.

1. Executive Summary

Please refer to accompanying document 60678525 Hounslow HMMP Executive Summary.

2. Introduction

This study is undertaken as part of *Programme One - Energy Efficiency* of Hounslow's *Climate Emergency Action Plan* and is the first stage of the governments Heat Network Delivery Unit (HNDU) plan of work.

Figure 2-1: HNDU Plan of Work

2.1 Project Drivers

On 18th June 2019, the London Borough of Hounslow (LBH) declared a Climate Emergency and committed the Council to reducing its direct emissions to net zero by 2030, alongside using such influence as it must to reduce wider emissions from across the Borough as quickly as possible.

In 2018/19[1], emissions from Hounslow Authority and Social Housing gas combustion (SH, DHW & Cooking) amounted to 38.5 ktCO2e/yr, with a further 8.3 ktCO2e/yr from Hounslow Authority and social housing electricity usage[2]. This equates to 79% and 17% of LBHs direct emissions respectfully (remaining 4% attributable to fleet and employee transport emissions).

As a borough, in 2019 Hounslow total emissions were 908 ktCO2e/yr, with circa. 37% attributed to gas combustion and 29% to electricity. Of the 37% attributed to gas, this is split across Industry and Commercial Gas, Public Sector Gas, and Domestic Gas (social and non-social housing). The proportion used for thermal energy generation is unknown, however can be assumed to be >80% of gas consumption.

In recent years, through the significant growth in renewable generation capacity, the UK electricity grid has significantly decarbonised and is predicted to continue reducing. It could be reasonably concluded therefore, that emissions from electricity will reduce in time, although demand reduction and local generation is critical to this being achieved.

Conversely, the natural gas grid is predicted to remain constantly high, and so could be considered to be the higher priority source of emissions to be mitigated locally, in particular in pursuit of achieving net-zero by 2030 for Hounslow Council emissions, for which gas represents the overwhelming majority.

District heating can offer a low carbon alternative to natural gas combustion for the generation of heat[3] and improved sustainable performance over local decarbonisation approaches i.e., local air source heat pumps.

In addition to carbon reductions, Hounslow also seeks to improve local air quality by reducing NOx and Particulate Matter (PM) pollutant levels within the borough, as part of the Air Quality Action Plan, approved in 2018. Through offsetting local gas combustion with electrically fuelled heat generation, district heating can contribute towards these ambitions, and is currently a key part of the planned measures[4].

One of the key objectives of this study is to identify opportunities for highly investible networks which offer an attractive Internal Rate of Return (IRR) in addition to carbon savings. Through discussions with LBH Council, and prior to the identification of a preferred commercial structure for said networks, the target 40-year IRR has been agreed to be 10%[5].

2.2 Objectives and Scope

The primary objective of this study is to identify opportunities for feasible low carbon district heating networks within the borough of Hounslow, which offer;

Sustainable Criteria	Description	Target Value
Environment	Reduce carbon emissions from buildings to which they connect[6]	<100gCO_2/kWh
Economic	Project financial performance	>[redacted]
Social	Heat tariffs equal, or less than, the agreed counterfactual	Project Heat Tariff <= Counterfactual Heat Tariff

Table 2-1: Project Quantitative Objectives

Finally, the identified networks should offer heat at a lower Levelised Cost of Heat than that of the alternative low carbon solutions in order to achieve the [redacted] The network should protect 'at-risk' customers (e.g., social housing tenants) from energy prices that may lead to risk of fuel poverty.

The agreed scope of this study is to assess the potential for a network within 6 clusters (areas of dense heat demand), as demonstrated on Figure 2-1. In addition, the potential for the amalgamation of multiple clusters into a single network is to be investigated, as well a high-level overview of a potential integration with Heathrow airport.

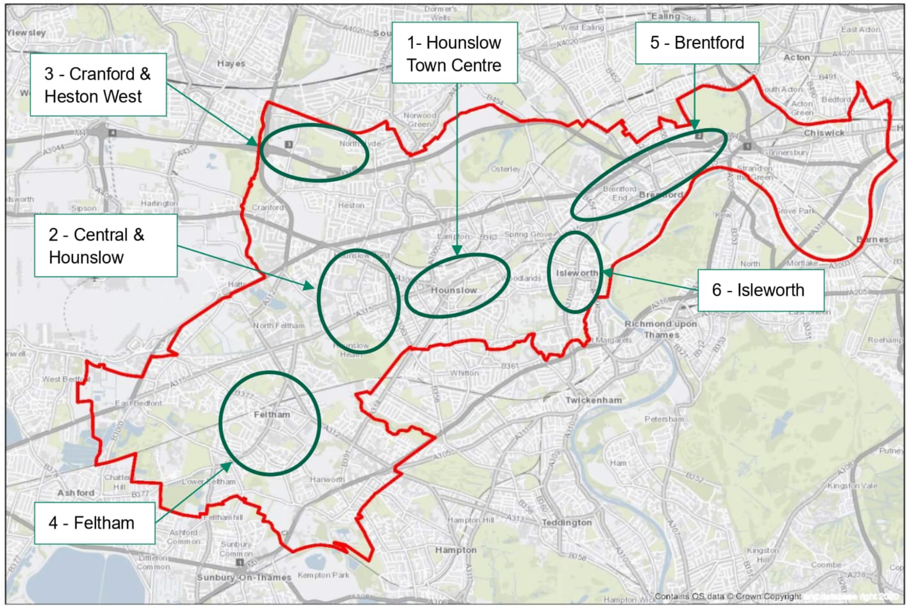

Figure 2-2: Study Red Line Boundary and the Six Clusters

Energy demand analysis, heat mapping, load profiling, conceptual design, and economic modelling has been carried out for each cluster individually and as part of a complete borough solution spanning five of the six clusters (excluding Cranford & Heston West). The following pages detail the results obtained

The ultimate output of this study is a recommendation of feasible network solutions which should be advanced to the next stage of design, feasibility. LBH may choose which, if any, of the recommended solutions they wish to pursue and can make an application to the HNDU for support in procuring this study.

[1] The latest dataset, unaffected by the impact of Covid.
[2] London Borough of Hounslow Climate and Clean Air Annual Report 2021
[3] Some industrial uses e.g., high temp. heat for manufacturer purposes are not technically compatible with DH
[4] London Borough of Hounslow Air Quality Annual Status Report for 2020
[5] This should be reviewed during subsequent design stages
[6] Value calculated using Green Heat Network Fund methodology

2.3 Heat Networks Code of Practice

CIBSE Heat Network Code of Practice for the UK (CP1) 2020 is the industry standard design guidance for heat networks and demonstration of compliance with its process is a requirement of the Green Heat Network Fund

The purposed of CP1 is:

- Create an evidence pack for each stage of network design which can be passed on to project teams (which typically change regularly throughout the lifespan of a project), without the loss of information and more importantly the targets / aims / key performance indicators
- Improve the quality of feasibility studies, design, construction, commissioning, and operation by setting minimum requirements for projects and identifying best practice options
- Deliver energy efficiency and environmental benefits
- Provide a good level of customer service.
- Promote long-lasting heat networks, in which customers and investors can have confidence.

AECOM have undertaken these works in accordance with the principles defined in CP1.

AECOM have developed a CP1 Stage 1 tracker and recommended statement of applicability in Appendix P. It is critical that this is reviewed and signed off (once satisfied with the contents) by LBH to maintain continuity of the process.

AECOM fully support the use of CP1 on all heat network projects. Should additional information be required on the impact, benefit and use of CP1 for a heat network project, this shall be provided outside of this report.

3. Policy & Local Context

In 2019, the London Borough of Hounslow (LBH) declared a Climate Emergency, committing the Council to achieving net zero for its direct emissions by 2030 and using its influence to reduce wider emissions across the borough as quickly as possible.

Heathrow Airport, an important neighbour of the borough of Hounslow, have an ambition to achieve net zero carbon for the airport infrastructure by the mid-2030s by transitioning away from gas [7].

The Greater London Authority's (GLA) Energy Assessment Guidance is highly supportive of district energy, particularly within Heat Network Priority Areas (HNPA)[8], with connection to existing or planned networks the top priority in the Energy Hierarchy.

In wider context, the UK government, in a 2019 amendment to the 2008 Climate Change Act, committed to achieving net zero by 2050. The Committee on Climate Change (CCC), in a 2015 report estimated that approximately 18% of the UKs heat demand would need to come from district heating to achieve this target cost-effectively, an increase of approximately 600% from today.

The UK government has demonstrated support for this rollout of district heating, having invested £320m through the Heat Networks Investment Project (HNIP), which closed in February 2022, with a further £270m allocated for the Green Heat Network Fund (GHNF), which opened in April 2022.

The UK government (BEIS) is currently undertaking a Heat Network Zoning Pilot study, which aims to identify zones where heat networks are the lowest cost, low carbon solution to decarbonising heat and may mandate buildings within that zone to connect, following a successful approach set by Denmark and Germany.

Heat Networks are also expected to play a significant role in the UK Governments new Future Homes Standard[9], planned to be implemented in 2025.

[7] TARGET NET ZERO | Heathrow Airport
[8] HNPAs are areas in London where the heat density is sufficient for heat networks to provide a competitive solution for supplying heat to buildings and consumers, and can be viewed at https://maps.london.gov.uk/heatmap

4. Methodology

The methodology followed in undertaking this Heat Mapping and Masterplanning study is demonstrated in Figure 4-1 below. Please refer to Appendix B for detailed methodology from Heat Mapping to Feasibility.

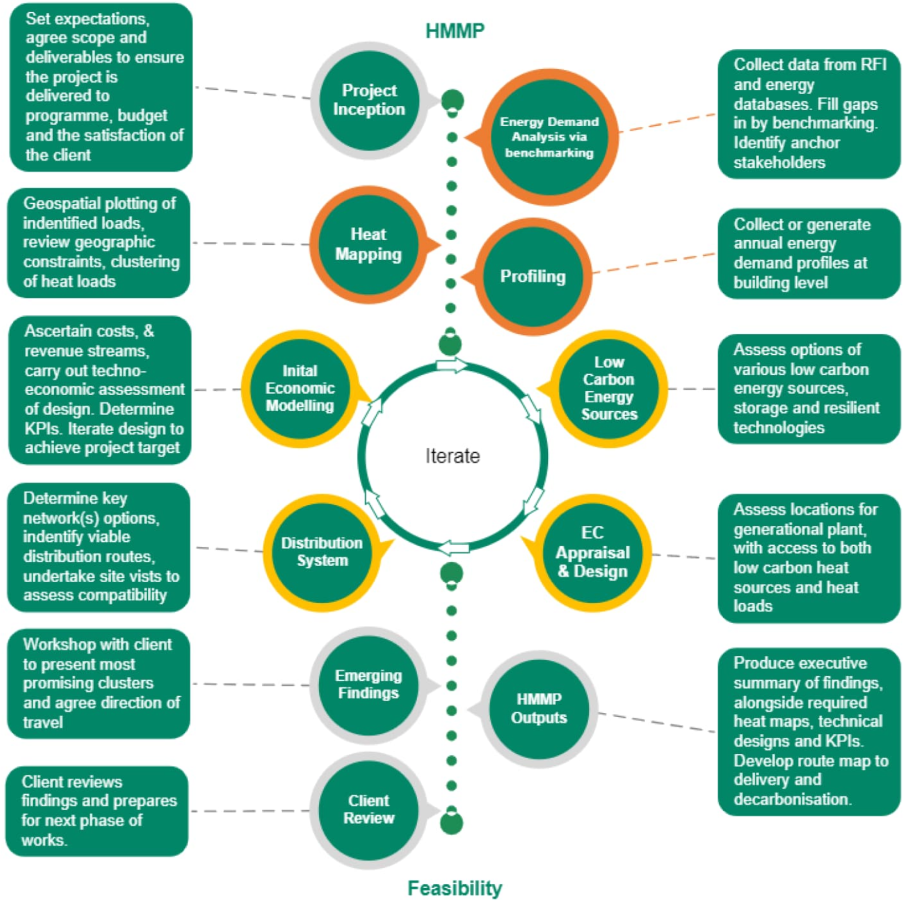

Figure 4-1: Diagram of heat mapping and masterplanning methodology.

[9] https://www.gov.uk/government/consultations/the-future-homes-standard-changes-to-part-l-and-part-f-of-the-building-regulations-for-new-dwellings

4.1 Energy Price Forecasts

The BEIS green book price factors used for modelling in this report align with HNDU requirements but do not reflect current market prices. Green book prices are lower than current 2022 market rates.

Geopolitical factors have inflated 2022 energy prices and may have a long-term impact on the energy market. If these conditions persist, the counterfactual system operational cost (i.e. the cost to customers of combusting gas in gas boilers, or utilising electricity in heat pumps) will be higher than that calculated in existing models. This would lead to a heat network heat sales tariff which may be higher than currently modelled whilst remaining equal cost to the counterfactual.

In this scenario of heightened energy prices, the variable cost to the network operator will also increase due to the increased input fuel prices, however, greater revenues from increased heat tariffs may provide a greater return on investment than is presented in this report. These heightened energy prices would likely result in an increase in fuel poverty given their significant increase from current levels. It should be noted that regardless of whether customers connect to the heat network or not, resultant real-world experienced costs will still remain dependent on wider market trends and prices.

Table 4-1 and Table 4-2 show a comparison of green book[10] domestic utility price factors compared to the 2022 Ofgem price caps inc. standing (October with Energy Price Guarantee)[11]. Figure 4-2 shows the green book price factors used in modelling.

Month-Year	Electricity Green Book Price Factors	Electricity Ofgem Price Cap
April-2022	21.5p/kWh	31.9p/kWh
October-2022	21.5p/kWh	38.0p/kWh

Month-Year	Gas Green Book Price Factors	Gas Ofgem Price Cap
April-2022	4.5p/kWh	7.8p/kWh
October-2022	4.5p/kWh	11.2p/kWh

Table 4-2: Comparison of Green Book domestic gas price factors to Ofgem price cap

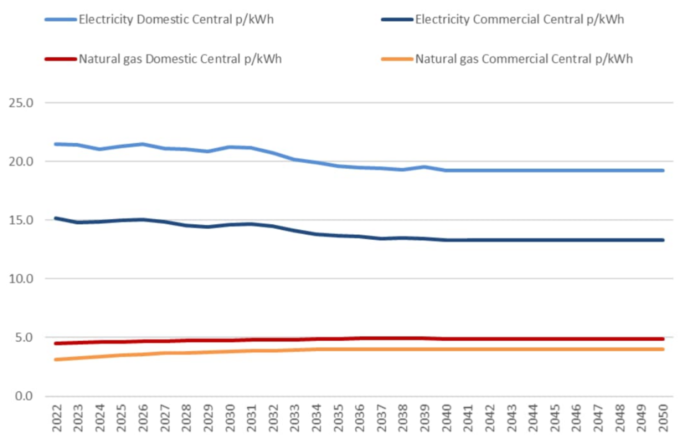

Figure 4-2: Graph of green book projected electricity and gas prices up to 2050

Sensitivity analysis has been carried out to assess the impact of increase fuel purchase prices to the network in line with HNDU specification, however, detailed alternative price scenarios should be modelled at feasibility stage to determine the impact of real current prices:

- Real current prices with rapid return to Green Book prices i.e., within 2 years
- Real current prices with slow return to Green Book prices i.e., within 6-10 years
- Real current prices with no return to Green Book prices

To enable the outputs of this report to hold value when considering to current energy prices, in the economic analysis section of each cluster, a comparison between the green book calculated heat tariff and the Heat Trust calculated heat tariff is included. This demonstrates the disparity between what has been modelled and reality.

The green book heat tariff calculated in the modelling of this report is equal to the counterfactual system costs which comprises plant CapEx, RepEx, and OpEx – capital, replacement, and operational expenditure. OpEx includes the cost of fuel which uses green book price factors. The Heat Trust Calculator[12] has similar CapEx and RepEx, but instead uses Ofgem's current April-2022 price cap to determine OpEx cost of fuel.

Worked example:

- a two-bed terraced house in Hounslow with gas boiler combusting 5,000kWh of gas per year (in line with the estimates in this modelling)
- customer has an assumed energy (blended fixed and variable) tariff cost o[redacted](using the Heat Trust Calculation) equal to [redacted]annum.
- (If we were to instead consider the newest price cap from Ofgem for October 2022, a conservative estimate of this annual cost would[redacted]).

In all future sections of this report where results are presented, the green book methodology heat tariff is compared to the current April 2022 Ofgem price cap figure in each cluster section to give a real-world frame of reference.

4.1.1 GHNF Aligned Counterfactuals

Green Heat Network Fund (GHNF) requires all existing domestic and micro-businesses to be assigned gas boiler counterfactuals. This is stipulated to ensure no customer detriment to customers at risk of fuel poverty, since gas boilers are a low-cost technology to purchase and operate, while also ensuring network techno economic modelling does not artificially inflate the price of the customer's comparator systems to make a network appear more financially viable than it is.

Assigning gas boiler counterfactual to customers, reduces network revenue due to the lower resultant heat tariff (which is set equal to the counterfactual cost). Gas boilers are, however, not a decarbonised solution. A building-level ASHP counterfactual is the most common alternative/comparator low carbon system to district heating and that is what is used as the counterfactual system for any customers outside of the above 'at-risk' category. Loads with ASHP counterfactual have a higher counterfactual cost – due to higher CapEx, RepEx and OpEx – and therefore are assigned a higher heat tariff.

There is a large proportion of loads with gas boiler counterfactuals in Hounslow due to the large proportion of social housing and other existing residential. This means there are many customers on comparatively cheap energy tariffs, and this effects the economic performance of the network. In addition, as discussed in section 4.1, BEIS green book fuel prices factors were used in modelling which magnifies this impact.

In future design stages, more refinement should be undertaken of the energy price forecasts as discussed in section 4.1 in order to update the counterfactual system costs and provide a more accurate view of the heat tariffs each customer would be charged.

[10] BEIS Green Book
[11] Energy bills support factsheet October 2022

[12] Heat Cost Calculator (heattrust.org)

5. Hounslow Town Centre

5.1 Energy Demand & Mapping

5.1.1 Heat Demand

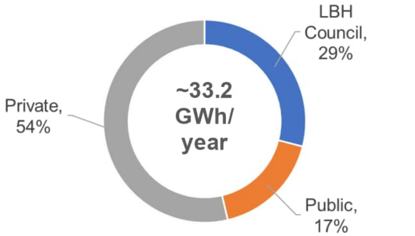

Figure 5-1: Hounslow Town Centre ownership of heat energy demand

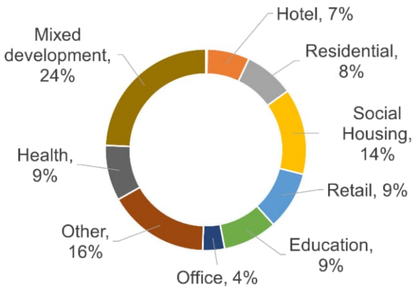

Figure 5-2: Hounslow Town Centre use type of heat energy demand

Undiversified (MW)	Diversified (MW)	Diversity
18.1	14.3	0.79

Table 5-1: Hounslow Town Centre network peak demand metrics

Note: see appendix C.3 for explanation of diversity.

ID	Load Name	Ownership	Annual Heat Demand (MWh)
32	High Street Quarter Development	Private	4,436
14	Blenheim Centre Hounslow	Private	2,328
36	Hounslow House	Local Authority	1,921
505	Isleworth Crown Court	Public	1,502
9	714-746 London Road (Charter Place, Ostler's Court)	Private	1,376

Table 5-2: Hounslow Town Centre anchor loads

Figure 5-3. shows the 92 loads that have been identified in Hounslow Town Centre, with the size of the circle indicating the scale of their heat demand. 52 of these 92 loads have been included in the proposed district heat network with the others qualitatively omitted for the reasons indicated in the Figure Legend, which includes: unsuitability of the load to connect to district heating (e.g., no communal system), existing use of a low carbon heat source, request from LBH to exclude pre-planning site allocations (possible future developments) post-2025 and requirement to make specialist crossing of an obstruction, e.g., railway. Excluded loads can be found in Appendix D.

There are areas of dense heat demand, particularly in the Southwest of the cluster, however, only 29% of the demand is from council owned loads. LBH has direct control over whether these buildings choose to connect to the network. Public sector buildings are next preferred due to the prevalent desire to achieve net-zero ambitions, followed by private sector which carry the highest risk of not choosing to connect. Future optimisation of the connected loads can be made to reduce the scale to a core network with a greater proportional of council owned loads, de-risking the delivery. The planned introduction of Heat Network Zoning offers a potential means to reduce the risk of key loads choosing not to connect through its proposed mandating of specific sites to connect to a network within a zone where this is the lowest cost decarbonisation solution.

There are significant loads to the Northern side of London Underground Piccadilly line which has been excluded from this assessment due to the specialist rail crossing required. There are several social housing estates that have been excluded from consideration as they are currently not supplied from a communal heat system and so require significant secondary side works to connect to district heating. These loads could undergo the required communal conversion of secondary systems and should be investigated in future; however, most have been excluded from this initial analysis. 1No. communal conversion has been recommended, see Section 5.5.4.2 for sensitivity analysis for the inclusion of this load.

The methodology for energy demand analysis and mapping is set out in Appendix C.3 & C.4. In addition to heating loads demonstrated here, electrical & cooling loads have also been mapped and can be found in Appendix F. Due to the higher carbon savings provide by heat networks (replacing gas) compared to cooling networks

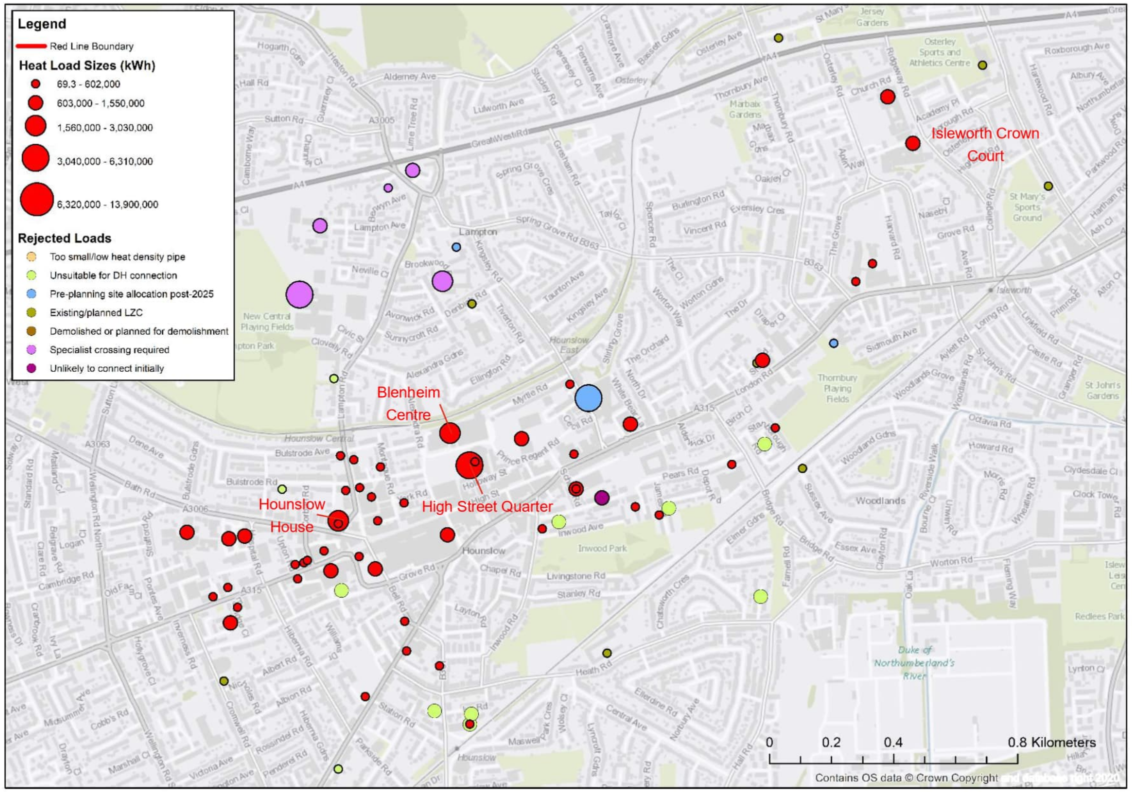

Figure 5-3: Hounslow Town Centre heat demand bubble map

5.2 Energy Centre Appraisals

To harness low and zero carbon heat (LZC), generate usable heat and deliver it via the network to connected buildings, Energy Centres (ECs) are required to host the necessary plant and equipment. The size of the ECs vary with capacity (power) of heat required to be delivered. This plant can be contained within suitable existing plantrooms or newly constructed, purpose-built buildings. To minimise infrastructure, it is preferred to locate ECs close to the preferred heat source and to the network customer buildings, however aspects such as land ownership and impact on residents and ecology are also considered.

Following the methodology set out in Appendix C.5.2, AECOM carried out an assessment to identify potential EC locations, and with LBH agreed the scoring criterion to qualitatively appraise these against each other. The complete appraisals can be found in Appendix G. An overview map with the key differentiating factors is shown in Figure 5-4 with factors coloured on a RAG scale according to their impact on the appraisal score. The highest scoring, and therefore, Preferred Option has been highlighted in green. This site was used in this initial technoeconomic modelling; however, all sites (and any others discovered in future) should be considered in future design stages.

Blenheim Centre plantroom is the best placed for proximity to heat demand however, the only accessible heat source is believed to be waste heat rejection from the existing cooling system, which is likely not of a sufficient scale or profile (available when required) for the demand required. Private ownership of this site also adds risk.

Land beside Greenham House is a relatively high scoring site since the site is under the control of LBH and is in close proximity to LZC in Thornbury Park, however, the EC would need to be either located next to residential buildings with access via a small cul-de-sac or on green space in Thornbury Park itself. This would likely cause disturbance to occupants.

Hounslow Vehicle Maintenance Depot sees the same benefits (with access to LZC at Inwood Park) but would use industrial use space on already developed land. The depot is proposed to be relocated from the current site at Pears Road, which provides the opportunity to integrate an EC into a newly developed site with minimal additional construction disturbance and minimal visual impact of the final building. In the event the vehicle depot remains at this site, a sufficient area of 700m² GIA has been located within the car park to build a new standalone energy centre (see Appendix I for layout). The resultant loss of car parking spaces is to be approved by LBH.

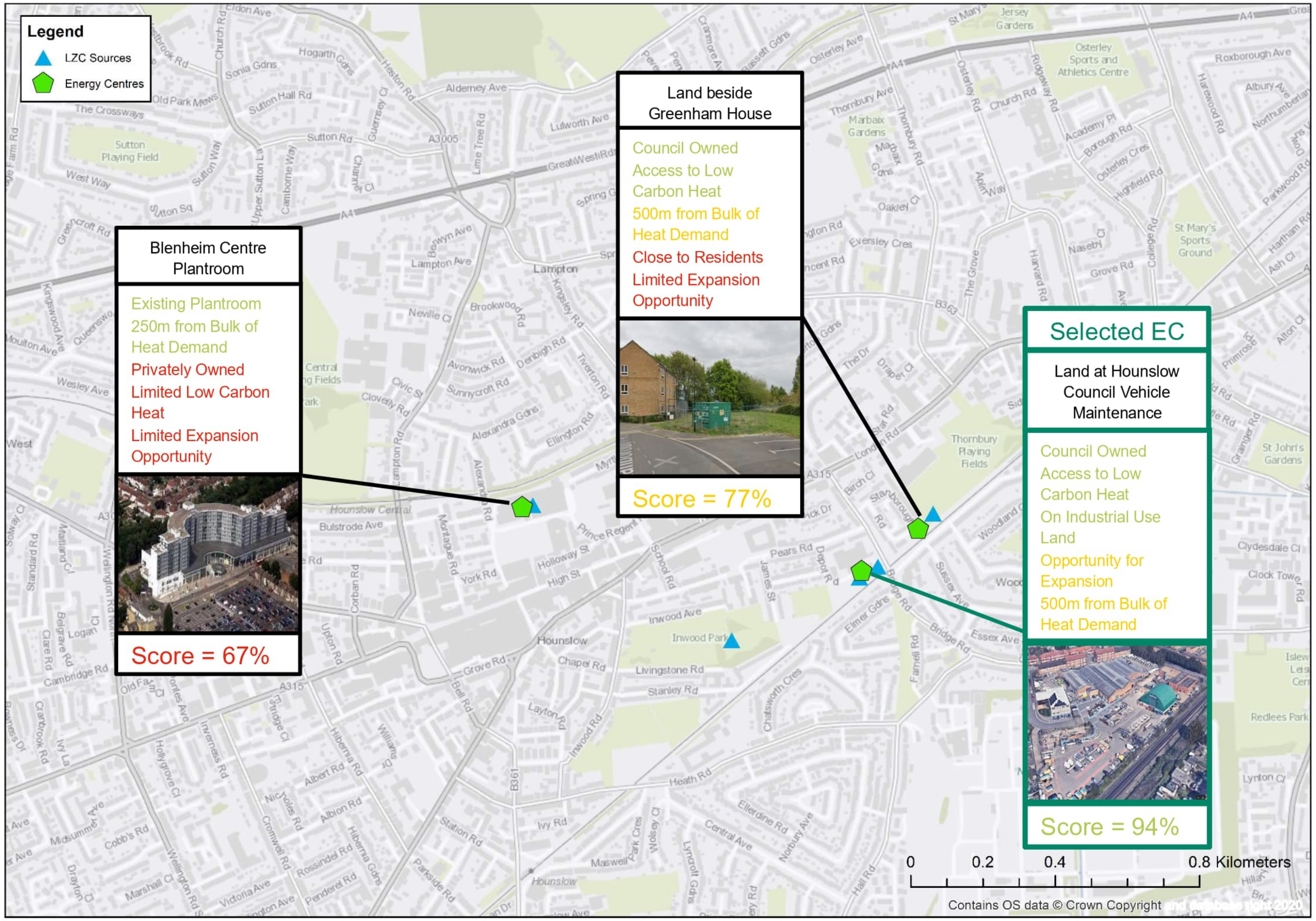

Figure 5-4: Hounslow Town Centre map of potential and selected energy centres

RAG: R=Red - a low or negative scoring criteria, A=Amber – a medium or neutral scoring parameter and G=Green – a high or positive scoring parameter

5.3 Low and Zero Carbon Heat Source Appraisals

To generate low and zero (LZC) carbon heat to supply the network, a source of ambient or waste heat is typically required. If this is 'low-grade' i.e., a lower temperature than is required by the network to serve the buildings it is connected to, then an electrically fuelled heat pump is required to boost this to a usable temperature.

Following the methodology set out in Appendix C.5.1, AECOM carried out an assessment to identify LZC source and with LBH agreed a scoring criterion to qualitatively appraise these against each other. The complete appraisals can be found in Appendix J. An overview map with the key differentiating factors is shown in Figure 5-5 with factors coloured on a RAG scale according to their impact on the appraisal score. The highest scoring, and therefore, Preferred Option has been highlighted in green. This source was used in this initial technoeconomic modelling; however, all sources (and any others discovered in future) should be considered in future design stages.

Waste heat recovery from Blenheim centre cooling and electrical transformer heat recovery scored poorly due to the likely inability to provide the scale and consistency of supply needed to meet demand. These sources are heavily dependent on agreements with third parties as well as on third party utilisation of the asset (use of cooling in the shopping centre, amount of electricity transmitted through the transformer) so are not well suited as the primary source.

Air-source heat pump is a good option however this would require significant, well-ventilated space to achieve the capacity needed. This technology is also inefficient during winter when demand is highest due to low air temperatures.

All other options are open-loop ground source heat which is a mature technology and is a secure source of ambient heat, the efficiency of which is relatively unaffected by weather conditions. To construct the boreholes required for this technology typically requires a large area of open space, suitable for the use of a drilling rig. The areas identified as the most promising are relatively close to each other and will likely provide similar flowrates. As such, proximity to the preferred EC is the main consideration, which meant Inwood Park was selected as the preferred location.

The available yield (heat capacity) from boreholes can be difficult to estimate and is typically based on historical yields of those in proximity. The preliminary hydrogeological undertaken in this study estimated that approx. 60% of the required yield could be obtained, however, with modern methods, this could be up to 100%. In this initial technoeconomic modelling, it is assumed that the full required bore hole yield can be achieved. Following detailed hydrogeological studies and bore hole testing, if it is discovered that the required bole hole yield cannot be achieved, air source heat pumps are the preferred secondary option to uplift generation capacity to the required levels. See Appendix K for hydrogeological assessment.

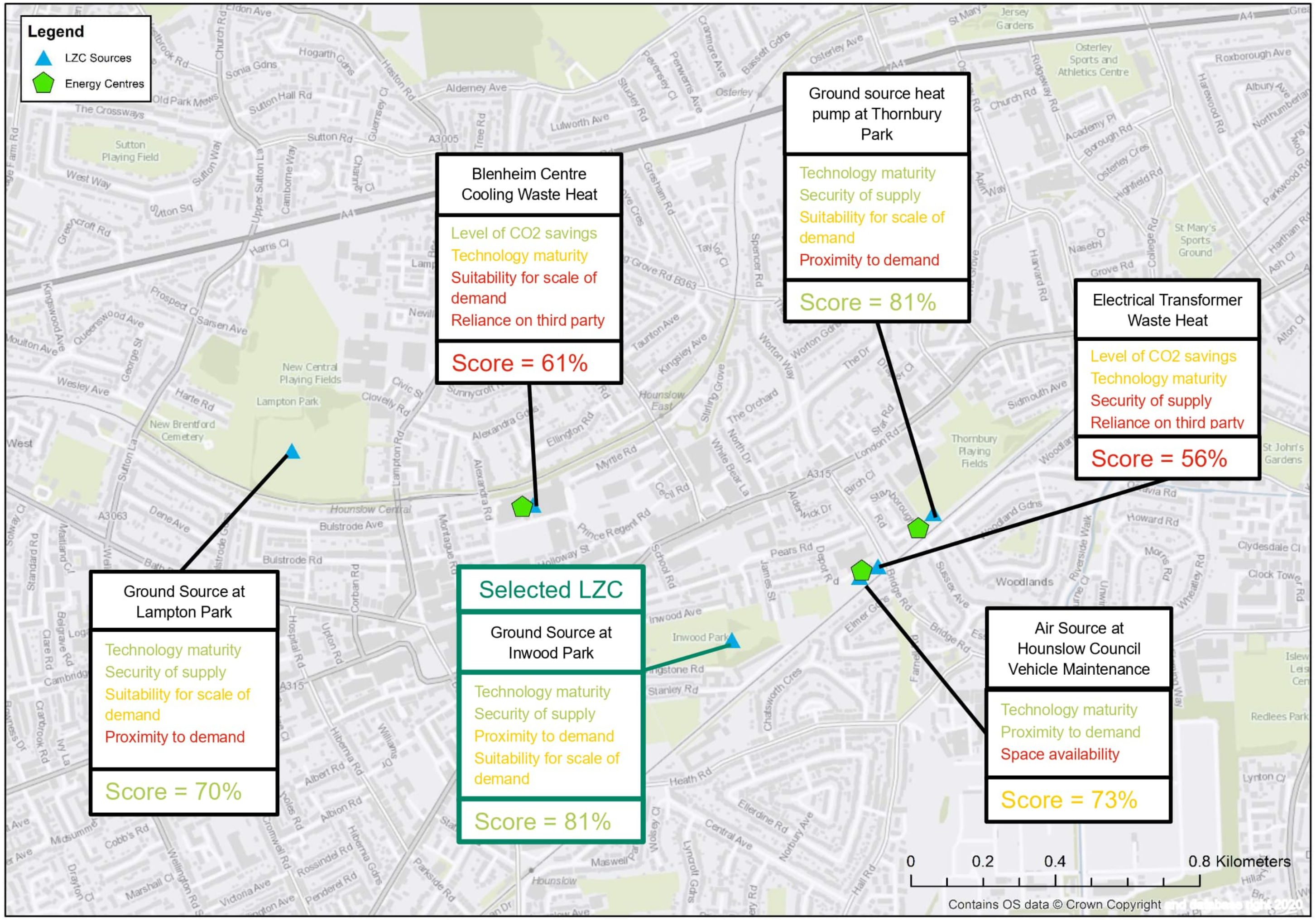

Figure 5-5: Hounslow Town Centre map of potential and selected LZC sources

5.4 Distribution System

This section details the initial proposed network to deliver heat from the energy centre to the customer buildings (loads). The pipe network shown in Figure 5-6 was designed in accordance with the methodology set out in Appendix C.6.

The network design was demand driven, in that the network has maximised the number of connectable loads to maximise the potential carbon savings from the project rather than being restricted by the available heat capacity, as noted in Section 5-3. In future design stages, the network extent can be refined to a "core" network that improves technical and economic performance at a smaller scale by including only anchor loads.

The key constraints are the Piccadilly Line to the North (overground section of the London Underground) and the overground railway to the South. Crossing these obstructions is extremely costly and adds complexity. Since the bulk of load is located between these constraints, the design decision has been made for the network to avoid these crossings. As shown in Figure 5-3, there is significant load to the North of the Piccadilly line which could be connected if the required crossing is found to be economical.

Pipe routing is a multi-objective optimisation problem: minimise cost and minimise distance. Different cost rates (£/m) are assigned to each section of pipe to reflect the different dig types. A dig type is a description of the type of ground in which trenches are made to install the network pipework, with more dense urban environments being more expensive than open grassed area. These cost rates use in this initial technoeconomic analysis can be found in Appendix O.2, Table 15-36, and their application on the route shown in Figure 5-6.

Hounslow Town Centre is mainly urban and extra-urban dig types, with the latter used along main A-roads. Where possible back roads have been used to avoid traffic disruptions during construction.

No specialist crossings have been identified (major road, river, or rail crossings).

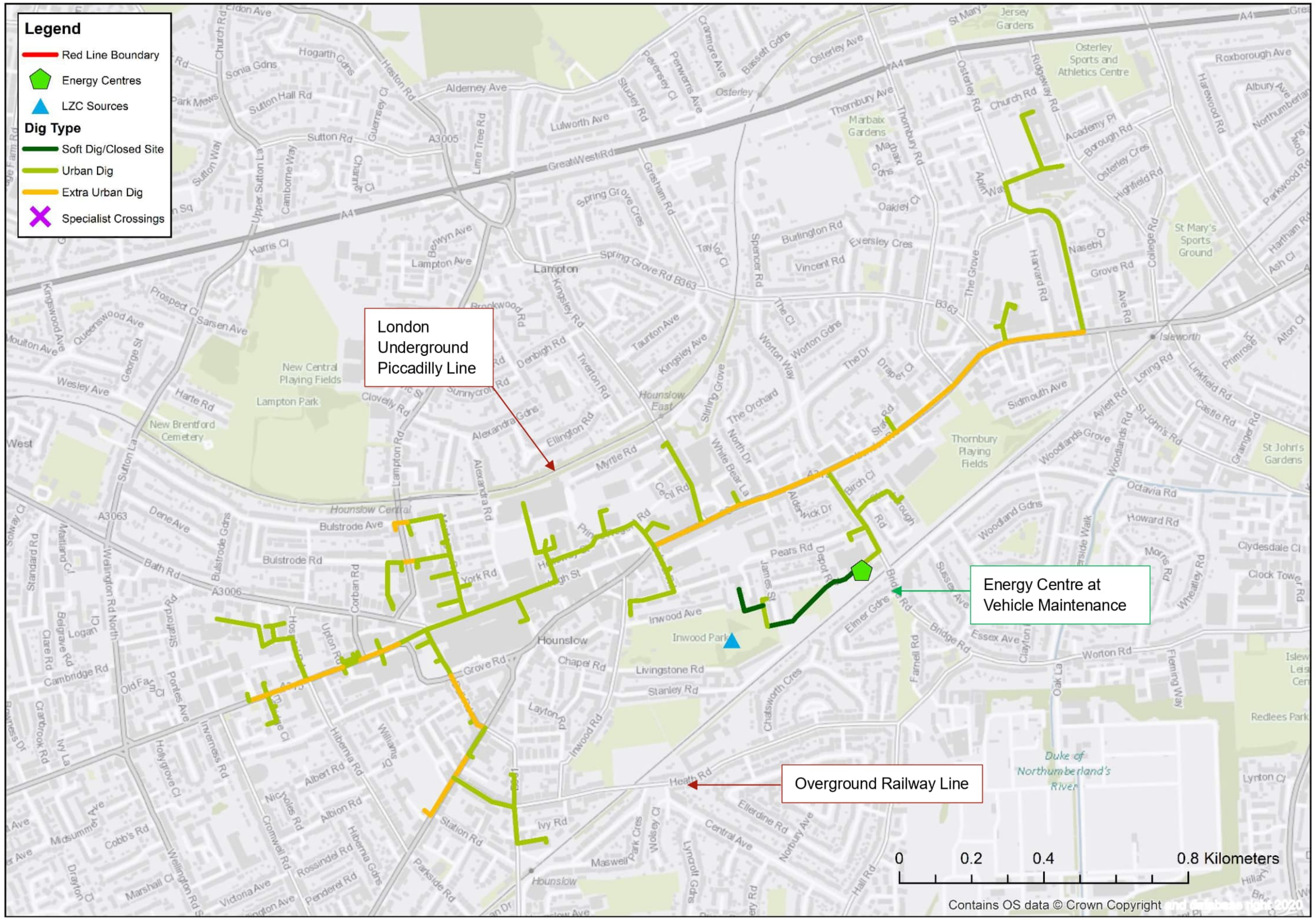

Figure 5-6: Hounslow Town Centre map of distribution system, dig types and constraints

Hounslow Town Centre is proposed as a heat-pump-led, third generation heating only network. A description of heat network technologies can be found in Appendix B.

A preliminary assessment of connected loads shows that ~85% currently require a ~80°C supply to provide the space heating comfort and domestic hot water requirements without fabric improvement and/or secondary side works. This is due to the age of the buildings and tendency for existing heating systems to operate on traditional 82°C/71°C temperature regimes which means these buildings are only suitable for connection to a high temperature third generation network. Connected buildings should be encouraged to undertake modifications to their buildings and systems to enable them to operate at lower temperatures without any compromise in comfort performance. If <u>all</u> connected buildings operated at a lower temperature the network supply temperature could be decreased becoming a fourth generation network with greater efficiency. Improved fabric should be the priority as this will also reduce consumption, but upgraded and rebalanced (optimised flow and return temperatures) heating systems should also be considered. The network has been modelled to include weather compensation to reduce operating temperatures during warmer weather when demand is lower, thereby reducing heat losses from the pipework. During winter the flow temperature is 80°C, which then reduces with increasing external air temperature, reaching a minimum of 70°C – require to generate domestic hot water in the 'worst case' connected loads. It is estimated that the network would operate at 70°C flow for over 90% the year, resulting in ~21% reduction in network losses and 16% increase in heat pump efficiency compared to a non-weather compensated network.

Steel pipework has been specified in lieu of PEX (plastic) to ensure the longevity of the infrastructure at the proposed operating temperatures and pressures.

In this initial technoeconomic modelling, the network construction commences in Q1 2027 in a single phase, achieving heat on to all loads in 2028. See high level project programme in Appendix Q. This programme will depend on the timeline for the subsequent design stages, the heat customer required connection dates and the availability of contractor resource to construct the network and their rate of install. It is possible that the preferred solution is found to be a phased installation of the network. These details are to be developed in future design stages, and upon completion of enhanced stakeholder engagement.

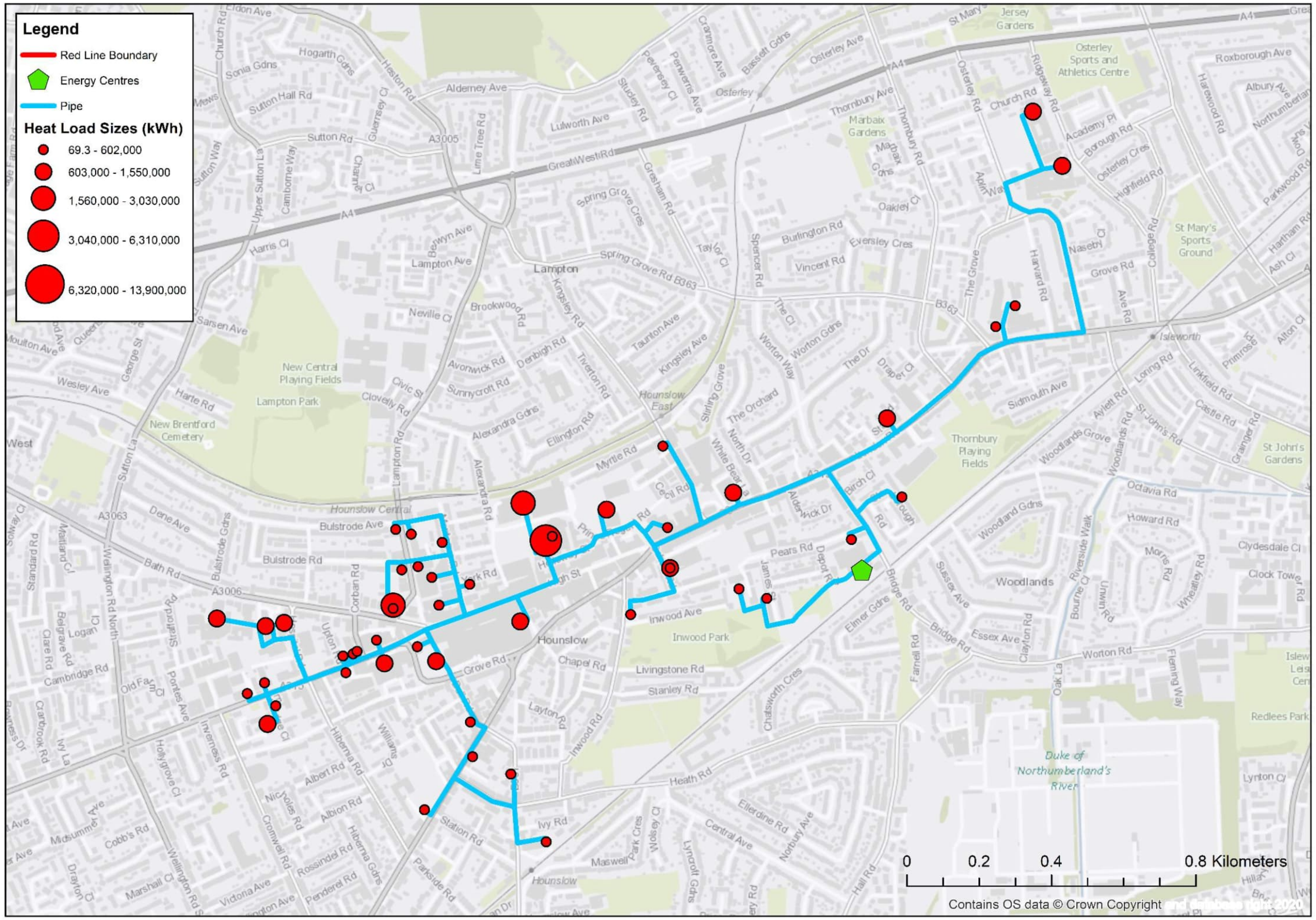

Figure 5-7: Hounslow Town Centre map of distribution system and connected loads

5.5 TEM Outputs

The above-described design for a district heating network has been analysed, to assess the performance of the solution against LBH environmental and economic aspirations. The methodology for techno-economic modelling is described in Appendix C.7 and the key modelling assumptions are detailed in Appendix O.

5.5.1 Generation Plant Specification

The generation plant detailed in Table 5-3 was determined through the initial technoeconomic modelling to achieve the target carbon intensity of heat of 100gCO2e/kWh (aligned with GHNF gated metrics and agreed with LBH) whilst satisfying the network demand with an economic plant composition and space efficient energy centre.

Attribute	Quantity
Energy Centre Internal Floor Area	700m²
Ground Source Heat Pump	2No. 1,875kW = 3,750kW
Heat Pump Refrigerant	Ammonia
Peaking and Resilient Gas Boiler	4No. 3,650kW = 14,600kW
Thermal Storage	180m³
Electrical Connection	2.1MVA

Table 5-3: Hounslow Town Centre generation plant specification

Initial design of the energy centre has been completed and is included in Appendix I. An application and budget request for a new electrical connection at the energy centre has been made to Scottish and Southern Electricity Network (SSEN), details of which can be found in Appendix L. The resultant budget quotes were formed without conducting grid analysis and therefore do not reflect potential grid reinforcement charges. The mitigate the risk of the cost in the formal quotation being higher than the budget figure, the cost of connection used in this initial technoeconomic analysis is based on previous projects rather than the quoted figures, however it is critical that these are reviewed in future design stages. The electrical grid is extremely constrained in West London, including Hounslow[13]. The GLA have warned significant new connection applications will not be approved until after 2035 once the grid can be reinforced. As such there is a risk that the 2.1MVA supply required for the energy centre may not be possible until that time.

5.5.2 Distribution System Specification

The key design metrics for the distribution system, as described in section 5.4 in demonstrated in Table 5-4 below:

Attribute	Quantity
Network Length	9,086m
Linear Heat Density	3,898 kWh/m
Flow/Return Temperatures	70-80°C / 40-50°C
Thermal Losses	

Table 5-4: Hounslow Town Centre distribution system specification

5.5.3 Environmental Performance

Table 5-5 demonstrates the environmental performance of the network solution in respective to carbon savings.

Parameter	Quantity
40-year Cumulative Carbon Savings vs Gas Boilers (tCO_2e)	202 ktCO2e
40-year Cumulative Carbon Savings vs Gas Boilers (%)	71.3%
Year 1 Carbon Intensity of Heat (gCO_2e/kWh)	98 gCO2e/kWh

Table 5-5: Hounslow Town Centre environmental performance

5.5.4 Economic Results & Optimisation

The base case techno-economic modelling results include no grant funding, a connection fee of (domestic and non-domestic) and a heat tariff equal to the counterfactual cost (this is assessed for each load individually, however, the **average** non-domestic tariff is shown below in Table 5-6 and the **average** domestic tariff is shown below in Table 5-7 as an indicator). Optimisations are made to the parameters of three revenue sources to assess the requirements to achieve the target IRR of

1. Grant Funding e.g., from the Green Heat Network Fund[14]
2. Increase in connection charge for non-domestic customers[15]
3. Increase in tariff for domestic customers

Fixed results (i.e., independent of the 3 revenue source variations detailed above) are shown in Table 5-6.

Parameter	Quantity
Heat Generation CapEx (£'mill)	
Distribution CapEx (£'mill)	
Total CapEx[16] (£'mill)	
Annual OpEx (£)	
Avg. Non-domestic tariff (p/kWh)	
Counterfactual Levelised Cost of Heat[17] (p/kWh)	

Table 5-6. Hounslow Town Centre fixed economic results

	Optimisation Scenario	Base case	Max grant	Max grant + increased commercial connection	Max Grant + increased commercial connection 2	Max Grant + increased domestic tariff
Optimisations	Grant funding (% of CapEx)					
	Non-domestic connection fee (£/kW)					
	Avg. Domestic tariff (p/kWh)					
Results	IRR 40-year (%)					
	Levelised Cost of Heat (p/kWh)					
	Social IRR 40-year (%)					

Table 5-7: Hounslow Town Centre optimisation results

Note: Optimisations have been highlighted red where the value differs from the base case.

[13] London Housing Development Faces Delays to 2035 on Electricity Capacity - Bloomberg
[14] The upper limit of this was determined by applying GHNF guidance
[15] Connection charge for non-domestic customers on low carbon networks are typically in the range
[16] Including 15% risk, contractor preliminaries, contractor overhead and profit, and design

[17] Counterfactual Levelised Cost of Heat across all domestic and non-domestic with GHNF aligned mixture of gas boiler and ASHP counterfactuals, respectfully. Value levelised using a discount rate of 3.5%. This value is NOT equal to the heat tariff. The heat tariff is equal to the non-levelised counterfactual cost for a single load assessed for each load individually. Counterfactual LCoH is used as comparison to the scheme LCoH only.

5.5.4.1 Domestic Tariff Impact

5.5.4.2 Sensitivity Analysis

In line with HNDU requirements, the impact of several key sensitivities were analysed, the results of which are demonstrated in Table 5-8.

Sensitivity	Variation	40-year pre-tax IRR
Generation and Supply CapEx		
Distribution CapEx		
Variable element of fuel input prices (electricity, gas, and waste heat)		
Variable element of energy sales tariffs for heat concurrent with variable element of fuel input prices (electricity, gas, and waste heat)		
Discount % against the counterfactual of the variable element of heat sales tariffs		
Heat demand usage change (loss of customers, gain of customers or building fabric efficiency savings)		
Effect of a significant reduction in availability of LZC or loss of waste heat source		
Heat network losses (primary/secondary)		
Goal-seek capital grant support necessary to meet		

Table 5-8: Hounslow Town Centre HNDU sensitivities

In addition to those stated above, a project specific sensitivity was also undertaken in relation to connection to social housing loads. In the core analysis, social housing loads which were fed from an existing communal heating system were included in the network. The core analysis also included some loads which were fed from individual systems (e.g. gas combi boilers in each unit). For the network to connect to the latter would require communal conversion at a greater cost and at greater complexity than to an existing communal system. Communal conversion will require funding outside the scope of this project.

In Hounslow Town Centre, Cromwell Estate was identified as an individual dwelling system that is suitable for communal conversion and was included in the core analysis. In the event these conversion works are not carried out and the load is not included in the network, the base case IRR will drop This drop in IRR was caused by reduced revenue from the heat tariff, which is greater than the average domestic heat tariff (due to increased counterfactual plant maintenance and replacement costs of these loads).

5.6 Summary

5.6.1 Key Risks

- The 2.1MVA supply required for the energy centre may not be possible until after 2035 due to grid constraints. It is possible that the cost of grid reinforcements may be higher than modelled and reduce the economic performance of the network.
- The yield from the aquifer bore hole may not achieve the required 56l/s and would need to be supplemented by another low carbon heat source or the network extent reduced.

See Appendix R for risk register.

5.6.2 Opportunities

- Existing use of proposed energy centre site (vehicle depot) is planned for relocation, providing the opportunity to redevelop the full site with an integrated energy centre.

See Appendix R for HNDU opportunities matrix.

5.6.3 Customer

Hounslow Town Centre has a large heat demand of 33.2GWh, however, this is concentrated in the Southwest and only 29% of the loads are council owned. Optimisation could be made to reduce the network extent to a core network with a greater proportional of council owned loads, de-risking the delivery and potential improving the IRR.

5.6.4 Engineering Solution

The high-level hydrogeology study estimated that a ground borehole yield of 60% flowrate of the aspiration would be probable, albeit further investigation is required. A reduction in yield could be accommodated by reducing the network extent or by supplementing with another technology such as an air source heat pump. With the space availability at LBH vehicle depot due to the relocation combined with the desire of LBH to decarbonise the borough, supplementing with ASHP would be the preferable option in order to meet decarbonisation targets.

The Energy Centre is located on council owned property; however, agreement will need to be made for the loss of space on site if the current use continues and a commercial agreement made if the whole site is to be redeveloped.

This network is considered to be technically feasible, however, alternative/additional low carbon heat sources may be needed.

[18] Heat Cost Calculator (heattrust.org)
[19] Consumer price inflation, UK - Office for National Statistics
[20] Ofgem 2019 price cap data

5.6.5 Economic & Environmental

The network This is a considerable carbon saving of 202 ktonnesCO2e over 40 years, which is equivalent to:

320,380

A round-trip economy ticket holder flying LHR -> JFK ->LHR (11,000km total) 320,380 times[21]

0.6% & 1.5%

0.6% of Hounslow's 40-year borough wide emissions and 1.5% of Hounslow's 40-year borough wide emissions from gas [22]

229,000

The carbon dioxide 229,000 mature tree's remove from the atmosphere in the same 40 years[23].

[21] International Civil Aviation Organisation ICAO Carbon Emissions Calculator
[22] London Borough of Hounslow Climate and Clean Air Annual Report 2021, 2019 data extrapolated over 40 years
[23] Tree Carbon Benefit -European Environment Agency

6. Central & Hounslow West

6.1 Energy Demand & Mapping

6.1.1 Heat Demand

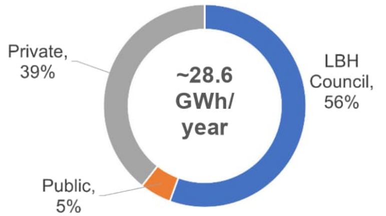

Figure 6-1: Central & Hounslow West ownership of heat demand

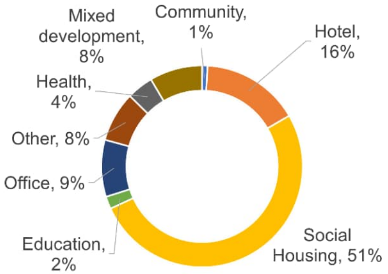

Figure 6-3: Central & Hounslow West use type of heat demand

Undiversified (MW)	Diversified (MW)	Diversity
15.5	12.6	0.81

Table 6-1: Central & Hounslow West network peak demand metrics

Note: see appendix C.3 for explanation of diversity.

ID	Load Name	Ownership	Annual Heat Demand (MWh)
100	Heathrow Corporate Park	Private	5,566
104	Hounslow Cavalry Barracks	Public	4,500
139	Wellington Day Centre	Local Authority	3,868
137	Tivoli Road Estate	Local Authority	2,254
102	Heathrow International Trading Estate (new) Development	Private	1,728

Table 6-2: Central & Hounslow West anchor loads

Figure 6-2. shows the 54 loads that have been identified in Central & Hounslow West, with the size of the circle indicating the scale of their heat demand. 25 of these 54 loads have been included in the proposed district heat network with the others qualitatively omitted for the reasons indicated in the Figure Legend, which includes: unsuitability of the load to connect to district heating (e.g., no communal system), existing use of a low carbon heat source, request from LBH to exclude pre-planning site allocations (possible future developments) post-2025 and requirement to make specialist crossing of an obstruction, e.g., railway. Excluded loads can be found in Appendix D.

This cluster has relatively sparse and low heat demand (in comparison to other clusters), however the location of demand is linear and as such conducive to heat network design. 56% of the demand is from council owned loads. LBH has direct control over whether these buildings choose to connect to the network which significantly de-risks delivery. The rest are mainly private sector which carry the highest risk of not choosing to connect. Social Housing is the largest load type and is key to the realisation of this network.

The planned introduction of Heat Network Zoning offers a potential means to reduce the risk of key loads choosing not to connect through its proposed mandating of specific sites to connect to a network within a zone where this is the lowest cost decarbonisation solution.

There are several social housing estates that have been excluded from consideration as they are currently not supplied from a communal heat system and so require significant secondary side works to connect to district heating. These loads could undergo the required communal conversion of secondary systems and should be investigated in future; however, most have been excluded from this initial analysis. 1No. communal conversion has been recommended, see Section 6.5.4.2 for sensitivity analysis of inclusion of this load.

The methodology for energy demand analysis and mapping is set out in Appendix C.3 & C.4. In addition to heating loads demonstrated here, electrical & cooling loads have also been mapped and can be found in Appendix F. Due to the higher carbon savings provide by heat networks (replacing gas) compared to cooling networks (replacing electrically driven air-source heat pumps), the preferred network solution is heating only.

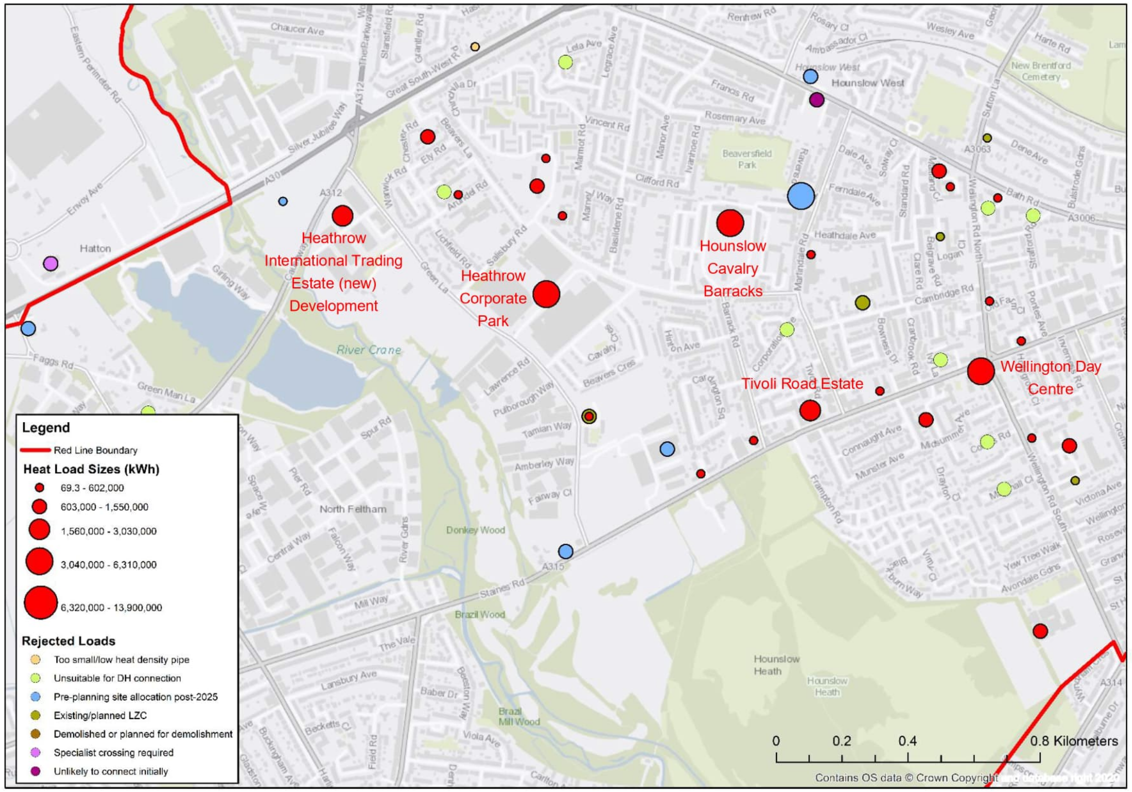

Figure 6-2: Central & Hounslow West heat demand bubble map

6.2 Energy Centre Appraisals

To harness low and zero carbon heat (LZC), generate usable heat and deliver it via the network to connected buildings, Energy Centres (ECs) are required to host the necessary plant and equipment. The size of the ECs vary with capacity (power) of heat required to be delivered. This plant can be contained within suitable existing plantrooms or newly constructed, purpose-built buildings. To minimise infrastructure, it is preferred to locate ECs close to the preferred heat source and to the network customer buildings, however aspects such as land ownership and impact on residents and ecology are also considered.

Following the methodology set out in Appendix C.5.2, AECOM carried out an assessment to identify potential EC locations, and with LBH agreed the scoring criterion to qualitatively appraise these against each other. The complete appraisals can be found in Appendix G. An overview map with the key differentiating factors is shown in Figure 6-4 with factors coloured on a RAG scale according to their impact on the appraisal score. The highest scoring, and therefore, Preferred Option has been highlighted in green. This site was used in this initial technoeconomic modelling; however, all sites (and any others discovered in future) should be considered in future design stages.

Council land around Beavers Primary School is a viable option however is the worst available because of the distance to the nearest low and zero carbon heat source, location within the cluster and disturbance to the education of students.

Similarly, an energy centre located at Heathland school may cause disturbance to students' education during construction and operation. If located on the playing fields, this would lead to loss of green space which is undesirable.

Hounslow Cavalry Barracks sees the same benefit of access to LZC but would use space on already developed land. The site is proposed for redevelopment, which provides the opportunity to integrate an EC into a newly developed site with minimal additional construction disturbance and minimal visual impact of the final building. A sufficient area of 700m² GIA has been located on site to build a new standalone energy centre (see Appendix I for layout). A positive response from the barracks would be needed to realise this solution.

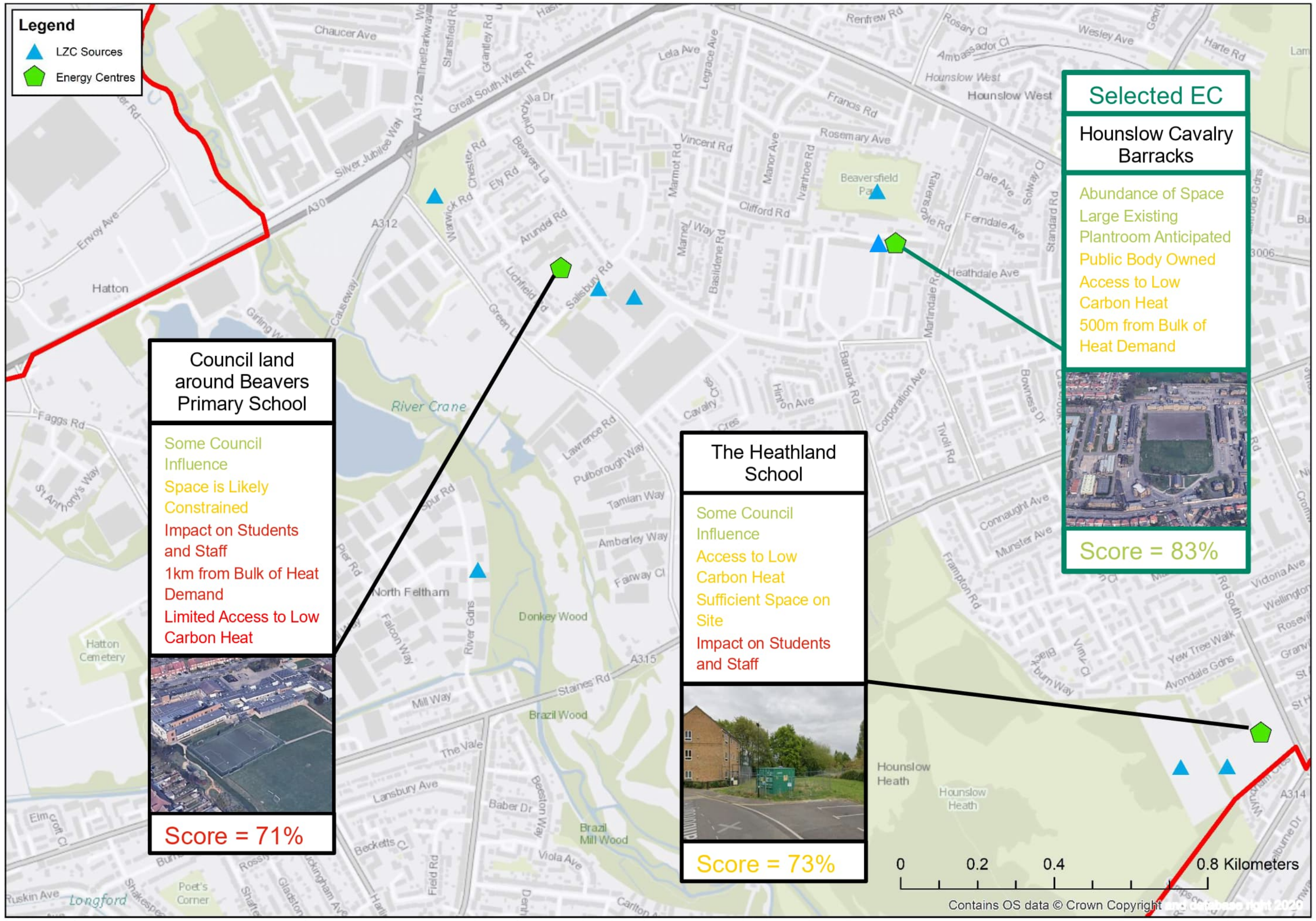

Figure 6-4: Central & Hounslow West map of potential and selected energy centres

RAG: R=Red - a low or negative scoring criteria, A=Amber – a medium or neutral scoring parameter and G=Green – a high or positive scoring parameter

6.3 Low and Zero Carbon Heat Source Appraisals

To generate low and zero (LZC) carbon heat to supply the network, a source of ambient or waste heat is typically required. If this is 'low-grade' i.e., a lower temperature than is required by the network to serve the buildings it is connected to, then an electrically fuelled heat pump is required to boost this to a usable temperature.

Following the methodology set out in Appendix C.5.1, AECOM carried out an assessment to identify LZC source and with LBH agreed a scoring criterion to qualitatively appraise these against each other. The complete appraisals can be found in Appendix J. An overview map with the key differentiating factors is shown in Figure 6-5 with factors coloured on a RAG scale according to their impact on the appraisal score. The highest scoring, and therefore, Preferred Option has been highlighted in green. This source was used in this initial technoeconomic modelling; however, all sources (and any others discovered in future) should be considered in future design stages.

Waste heat recovery from the data centre and electrical transformer heat recovery scored poorly due to the likely inability to provide the scale and consistency of supply needed to meet demand. These sources are heavily dependent on agreements with third parties as well as on third party utilisation of the asset (use of cooling in the data centre, amount of electricity transmitted through the transformer) so are not well suited as the primary source.

Air-source heat pump is a good option however this would require significant, well-ventilated space to achieve the capacity needed. This technology is also inefficient during winter when demand is highest due to low air temperatures.

All other options are open-loop ground source heat which is a mature technology and is a secure source of ambient heat, the efficiency of which is relatively unaffected by weather conditions. To construct the boreholes required for this technology typically requires a large area of open space, suitable for the use of a drilling rig. The areas identified as the most promising are relatively close to each other and will likely provide similar flowrates. As such, proximity to the preferred EC is the main consideration, which meant Hounslow Cavalry Barracks was selected as the preferred location. Note: this is an exception as Ground source at Beavers Park scores higher since this is council owned, however if the barracks EC is established it is assumed that the bore holes will also be possible.

The available yield (heat capacity) from boreholes can be difficult to estimate and is typically based on historical yields of those in proximity. The preliminary hydrogeological undertaken in this study estimated that approx.60% of the required yield could be obtained, however, with modern methods, this could be up to 100%. In this initial technoeconomic modelling, it is assumed that the full required bore hole yield can be achieved. Following detailed hydrogeological studies and bore hole testing, if it is discovered that the required bole hole yield cannot be achieved. air source heat pumps are the preferred secondary

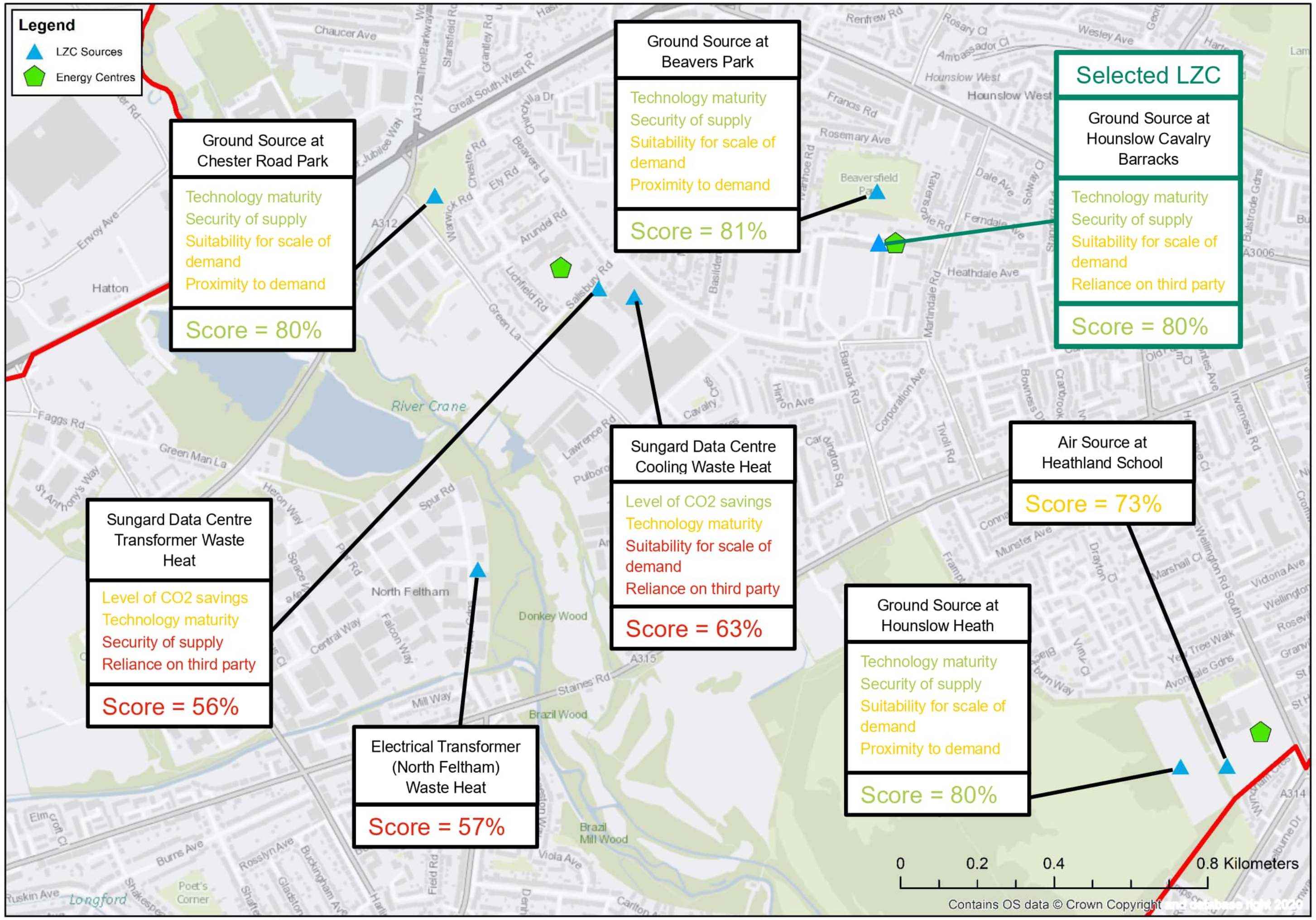

Figure 6-5: Central & Hounslow West map of potential and selected LZC sources

6.4 Distribution System

This section details the initial proposed network to deliver heat from the energy centre to the customer buildings (loads). The pipe network shown in Figure 6-6 was designed in accordance with the methodology set out in Appendix C.6.

The network design was demand driven, in that the network has maximised the number of connectable loads to maximise the potential carbon savings from the project rather than being restricted by the available heat capacity, as noted in Section 6.3. In future design stages, the network extent can be refined to a “core” network that improves technical and economic performance at a smaller scale by including only anchor loads.

The key constraints limiting the network are the River Crane to the West and the A30 to the North. Crossing these obstructions is costly and adds complexity. The design decision has been made for the network to avoid these obstructions and reduce the number of connected loads.

Pipe routing is a multi-objective optimisation problem: minimise cost and minimise distance. Different cost rates (£/m) are assigned to each section of pipe to reflect the different dig types. A dig type is a description of the type of ground in which trenches are made to install the network pipework, with more dense urban environments being more expensive than open grassed area. These cost rates use in this initial technoeconomic analysis can be found in Appendix O.2, Table 15-36, and their application on the route shown in Figure 6-6.

Central & Hounslow West is mainly urban and extra-urban dig types, with the latter used along main A-roads. Where possible back roads have been used to avoid traffic disruptions during construction. A significant extra-urban section along the A3063 was unavoidable to access to the proposed loads and low/zero carbon heat source.

No specialist crossings have been identified (major road, river, or rail crossings).

Figure 6-6: Central & Hounslow West map of distribution system, dig types and constraints

Central & Hounslow West is proposed as a heat-pump-led, third generation heating only network. A description of heat network technologies can be found in Appendix B.

A preliminary assessment of connected loads shows that ~88% currently require a ~80°C supply to provide the space heating comfort and domestic hot water requirements without fabric improvement and/or secondary side works. This is due to the age of the buildings and tendency for existing heating systems to operate on traditional 82°C/71°C temperature regimes which means these buildings are only suitable for connection to a high temperature third generation network. Connected buildings should be encouraged to undertake modifications to their buildings and systems to enable them to operate at lower temperatures without any compromise in comfort performance. If <u>all</u> connected buildings operated at a lower temperature the network supply temperature could be decreased becoming a fourth generation network with greater efficiency. Improved fabric should be the priority as this will also reduce consumption, but upgraded and rebalanced (optimised flow and return temperatures) heating systems should also be considered. The network has been modelled to include weather compensation to reduce operating temperatures during warmer weather when demand is lower, thereby reducing heat losses from the pipework. During winter the flow temperature is 80°C, which then reduces with increasing external air temperature, reaching a minimum of 70°C – require to generate domestic hot water in the 'worst case' connected loads. It is estimated that the network would operate at 70°C flow for over 90% the year, resulting in ~21% reduction in network losses and 16% increase in heat pump efficiency compared to a non-weather compensated network.

Steel pipework has been specified in lieu of PEX (plastic) to ensure the longevity of the infrastructure at the proposed operating temperatures and pressures.

In this initial technoeconomic modelling, the network construction commences in Q1 2027 in a single phase, achieving heat on to all loads in 2028. See high level project programme in Appendix Q. This programme will depend on the timeline for the subsequent design stages, the heat customer required connection dates and the availability of contractor resource to construct the network and their rate of install. It is possible that the preferred solution is found to be a phased installation of the network. These details are to be developed in future design stages, and upon completion of enhanced stakeholder engagement.

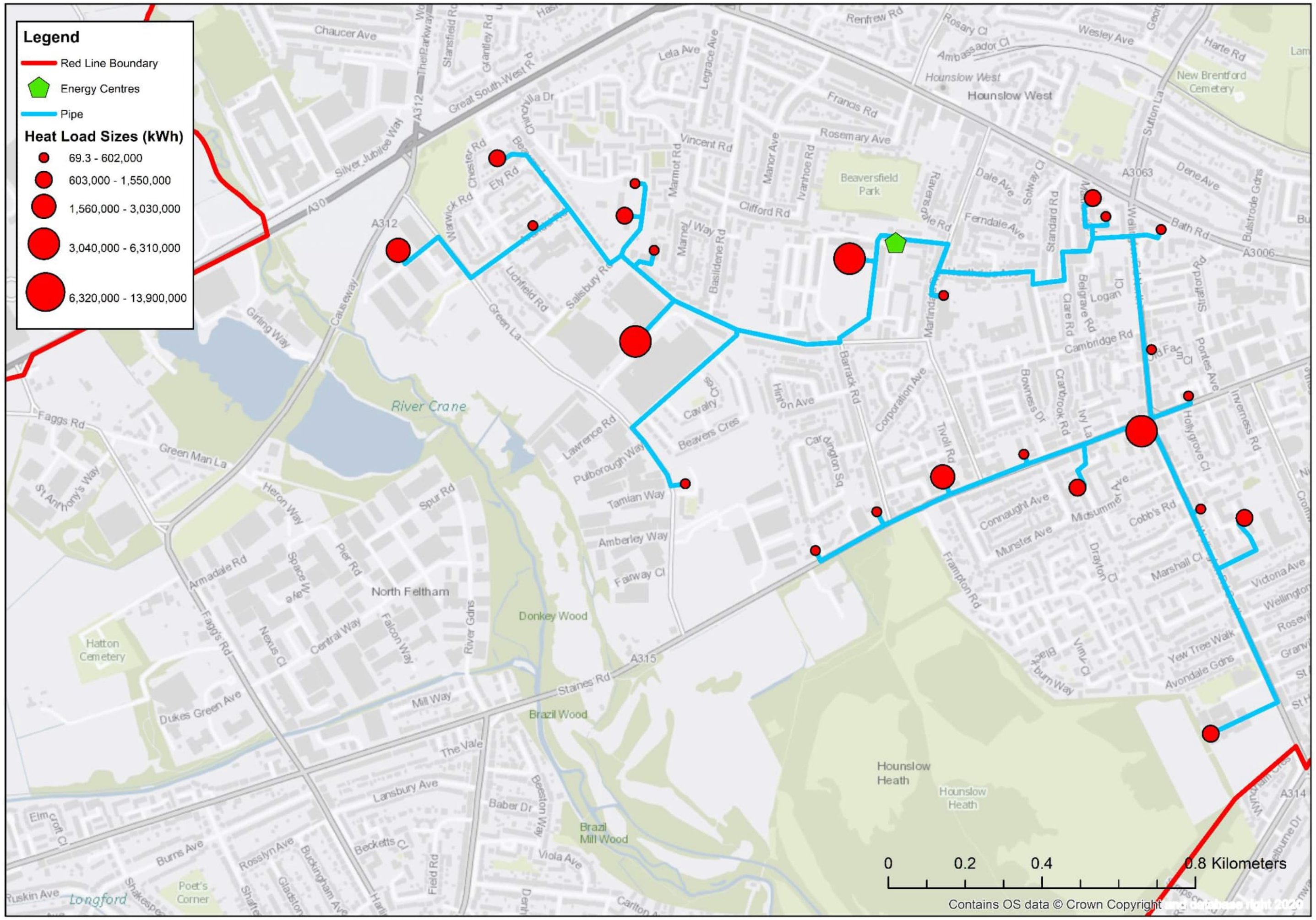

Figure 6-7: Central & Hounslow West map of distribution system and connected loads

6.5 TEM Outputs

The above-described design for a district heating network has been analysed, to assess the performance of the solution against LBH environmental and economic aspirations. The methodology for techno-economic modelling is described in Appendix C.7 and the key modelling assumptions are detailed in Appendix O.

6.5.1 Generation Plant Specification

The generation plant detailed in Table 6-3 was determined through the initial technoeconomic modelling to achieve the target carbon intensity of heat of 100gCO2e/kWh (aligned with GHNF gated metrics and agreed with LBH) whilst satisfying the network demand with an economic plant composition and space efficient energy centre.

Attribute	Quantity
Energy Centre Internal Floor Area	700m²
Ground Source Heat Pump	2No. 1,625kW = 3,250kW
Heat Pump Refrigerant	Ammonia
Peaking and Resilient Gas Boiler	4No. 3,225kW = 12,900kW
Thermal Storage	160m³
Electrical Connection	1.8MVA

Table 6-3: Central & Hounslow West generation plant specification

Initial design of the energy centre has been completed and is included in Appendix I. An application and budget request for a new electrical connection at the energy centre has been made to Scottish and Southern Electricity Network (SSEN), details of which can be found in Appendix L. The resultant budget quotes were formed without conducting grid analysis and therefore do not reflect potential grid reinforcement charges. The mitigate the risk of the cost in the formal quotation being higher than the budget figure, the cost of connection used in this initial technoeconomic analysis is based on previous projects rather than the quoted figures, however it is critical that these are reviewed in future design stages. The electrical grid is extremely constrained in West London, including Hounslow[24]. The GLA have warned significant new connection applications will not be approved until after 2035 once the grid can be reinforced. As such there is a risk that the 1.8MVA supply required for the energy centre may not be possible until that time.

6.5.2 Distribution System Specification

The key design metrics for the distribution system, as described in section 6.4 in demonstrated in Table 6-4 below:

Attribute	Quantity
Network Length	7,698m
Linear Heat Density	3,981 kWh/m
Flow/Return Temperatures	70-80°C / 40-50°C
Thermal Losses	[redacted]

Table 6-4: Central & Hounslow West distribution system specification

6.5.3 Environmental Performance

Table 6-5 demonstrates the environmental performance of the network solution in respective to carbon savings.

Parameter	Quantity
40-year Cumulative Carbon Savings vs Gas Boilers (tCO_2e)	[redacted]
40-year Cumulative Carbon Savings vs Gas Boilers (%)	
Year 1 Carbon Intensity of Heat (gCO_2e/kWh)	

Table 6-6: Central & Hounslow West environmental performance

6.5.4 Economic Results & Optimisation

The base case techno-economic modelling results include no grant funding, [redacted] (domestic and non-domestic) and a heat tariff equal to the counterfactual cost (this is assessed for each load individually, however, the **average** non-domestic tariff is shown below in Table 5-6 and the **average** domestic tariff is shown below in Table 5-7 as an indicator). Optimisations are made to the parameters of three revenue sources to assess the requirements to achieve the target IRR of [redacted]

1. Grant Funding e.g., from the Green Heat Network Fund[25]
2. Increase in connection charge for non-domestic customers[26]
3. Increase in tariff for domestic customers

Fixed results (i.e., independent of the 3 revenue source variations detailed above) are shown in Table 6-6.

Parameter	Quantity
Heat Generation CapEx (£'mill)	[redacted]
Distribution CapEx (£'mill)	
Total CapEx[27] (£'mill)	
Annual OpEx (£)	
Avg. Non-domestic tariff (p/kWh)	
Counterfactual Levelised Cost of Heat[28] (p/kWh)	

Table 6-7: Central & Hounslow West fixed economic results

	Optimisation Scenario	Base case	Max grant	Max grant + increased commercial connection	Max Grant + increased commercial connection 2	Max Grant + increased domestic tariff
Optimisations	Grant funding (% of CapEx)	[redacted]				
	Non-domestic connection fee (£/kW)					
	Avg. Domestic tariff (p/kWh)					
Results	IRR 40-year (%)					
	Levelised Cost of Heat (p/kWh)					
	Social IRR 40-year (%)					

Note: Optimisations have been highlighted red where the value differs from the base case.

Table 6-5: Central & Hounslow West optimisation results

[24] London Housing Development Faces Delays to 2035 on Electricity Capacity - Bloomberg
[25] The upper limit of this was determined by applying GHNF guidance
[redacted]

[28] Counterfactual Levelised Cost of Heat across all domestic and non-domestic with GHNF aligned mixture of gas boiler and ASHP counterfactuals, respectfully. Value levelised using a discount rate of 3.5%. This value is NOT equal to the heat tariff. The heat tariff is equal to the non-levelised counterfactual cost for a single load assessed for each load individually. Counterfactual LCoH is used as comparison to the scheme LCoH only.

6.5.4.1 Domestic Tariff Impact

[redacted]

6.5.4.2 Sensitivity Analysis

In line with HNDU requirements, the impact of several key sensitivities were analysed, the results of which are demonstrated in Table 6-8.

Sensitivity	Variation	40-year pre-tax IRR
Generation and Supply CapEx	[redacted]	
Distribution CapEx		
Variable element of fuel input prices (electricity, gas, and waste heat)		
Variable element of energy sales tariffs for heat concurrent with variable element of fuel input prices (electricity, gas, and waste heat)		
Discount % against the counterfactual of the variable element of heat sales tariffs		
Heat demand usage change (loss of customers, gain of customers or building fabric efficiency savings)		
Effect of a significant reduction in availability of LZC or loss of waste heat source	[redacted]	
Heat network losses (primary/secondary)		
Goal-seek capital grant support necessary to m[redacted]		

Table 6-8: Central & Hounslow West HNDU sensitivities

In addition to those stated above, a project specific sensitivity was also undertaken in relation to connection to social housing loads. In the core analysis, social housing loads which were fed from an existing communal heating system were included in the network. The core analysis also included some loads which were fed from individual systems (e.g. gas combi boilers in each unit). For the network to connect to the latter would require communal conversion at a greater cost and at greater complexity than to an existing communal system. Communal conversion will require funding outside the scope of this project.

In Central & Hounslow West, Clements Court Estate was identified as individual dwelling system that is suitable for communal conversion and was included in the core analysis. In the event these conversion works are not carried out and the load is not included in the network, the base case IRR will drop [redacted] This drop in IRR by [redacted]

6.6 Summary

6.6.1 Key Risks

- The 1.8MVA supply required for the energy centre may not be possible until after 2035 due to grid constraints. It is possible that the cost of grid reinforcements may be higher than modelled and reduce the economic performance of the network.
- The yield from the aquifer bore hole may not achieve the required 49l/s and would need to be supplemented by another low carbon heat source or the network extent reduced.
- Lack of interest from Hounslow Cavalry Barracks eliminating possibility energy centre location.

See Appendix R for risk register.

6.6.2 Opportunities

- Central & Hounslow West could act as a conduit to access Heathrow Airport.

See Appendix R for HNDU opportunities matrix.

6.6.3 Customer

Central & Hounslow West has one of the lower heat demands of the assessed clusters, however 56% of the heat demand is from loads which are council owned, which reduces the risk of loss of customers.

6.6.4 Engineering Solution

The high-level hydrogeology study estimated that a ground borehole yield of 60% flowrate of the aspiration would be probable, albeit further investigation is required. A reduction in yield could be accommodated by reducing the network extent or by supplementing with another technology such as an air source heat pump. With the desire of LBH to decarbonise the borough, supplementing with ASHP would be the preferable option in order to meet decarbonisation targets.

No major physical barriers to the construction of the proposed distribution network were identified which reduces the risk of cost or programme implications.

The network is considered to be technical feasible however is dependent on agreement with the Hounslow Cavalry Barracks for the use of their land to locate the Energy Centre. The commercial implications of any such agreement are currently unknown but may impact the delivery of the project.

[29] Heat Cost Calculator (heattrust.org)
[30] Consumer price inflation, UK - Office for National Statistics
[31] Ofgem 2019 price cap data

6.6.5 Economic & Environmental

The network CapEx c This is a considerable carbon saving of 174 ktonnesCO2e over 40 years, which is equivalent to:

275,971

A round-trip economy ticket holder flying LHR -> JFK ->LHR (11,000km total) 275,971 times[32]

0.5% & 1.3%

0.5% of Hounslow's 40-year borough wide emissions and 1.3% of Hounslow's 40-year borough wide emissions from gas [33]

197,727

The carbon dioxide 197,727 mature tree's remove from the atmosphere in the same 40 years[34].

[32] International Civil Aviation Organisation ICAO Carbon Emissions Calculator
[33] London Borough of Hounslow Climate and Clean Air Annual Report 2021, 2019 data extrapolated over 40 years
[34] Tree Carbon Benefit -European Environment Agency

7. Cranford & Heston West

7.1 Energy Demand & Mapping

7.1.1 Heat Demand

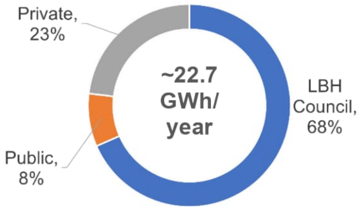

Figure 7-1: Cranford & Heston West ownership of heat demand

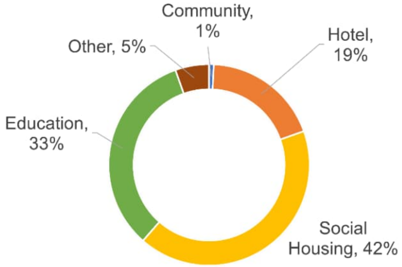

Figure 7-2: Cranford & Heston West use type of heat demand

Undiversified (MW)	Diversified (MW)	Diversity
12.0	10.4	0.87

Table 7-1: Cranford & Heston West network peak demand metrics

Note: see appendix C.3 for explanation of diversity.

ID	Load Name	Ownership	Annual Heat Demand (MWh)
155	David Lloyd Heston	Private	5,611
178	Redwood Estate	Local Authority	3,579
150	Convent Way Estate (existing)	Local Authority	1,957
170	Moxy London	Private	1,859
185	Ibis Heathrow Central	Private	1,716

Table 7-2: Cranford & Heston West anchor loads

Figure 7-3 shows the 46 loads that have been identified in Cranford & Heston West, with the size of the circle indicating the scale of their heat demand. 18 of these 46 loads have been included in the proposed district heat network with the others qualitatively omitted for the reasons indicated in the Figure Legend, which includes: unsuitability of the load to connect to district heating (e.g., no communal system), existing use of a low carbon heat source, request from LBH to exclude pre-planning site allocations (possible future developments) post-2025 and requirement to make specialist crossing of an obstruction, e.g., railway. Excluded loads can be found in Appendix D.

This cluster has extremely sparse and low heat demand (in comparison to other clusters). 68% of the demand is from council owned loads. LBH has direct control over whether these buildings choose to connect to the network which significantly de-risks delivery. The rest are mainly private sector which carry the highest risk of not choosing to connect. Social Housing is the largest load type and is key to the realisation of this network. The planned introduction of Heat Network Zoning offers a potential means to reduce the risk of key loads choosing not to connect through its proposed mandating of specific sites to connect to a network within a zone where this is the lowest cost decarbonisation solution.

There are several social housing estates that have been excluded from consideration as they are currently not supplied from a communal heat system and so require significant secondary side works to connect to district heating. These loads could undergo the required communal conversion of secondary systems and should be investigated in future; however, most have been excluded from this initial analysis. 2No. communal conversion has been recommended, see Section 7.5.4.2 for sensitivity analysis of inclusion of these loads.

The methodology for energy demand analysis and mapping is set out in Appendix C.3 & C.4. In addition to heating loads demonstrated here, electrical & cooling loads have also been mapped and can be found in Appendix F. Due to the higher carbon savings provide by heat networks (replacing gas) compared to cooling networks (replacing electrically driven air-source heat pumps), the preferred network solution is heating only.

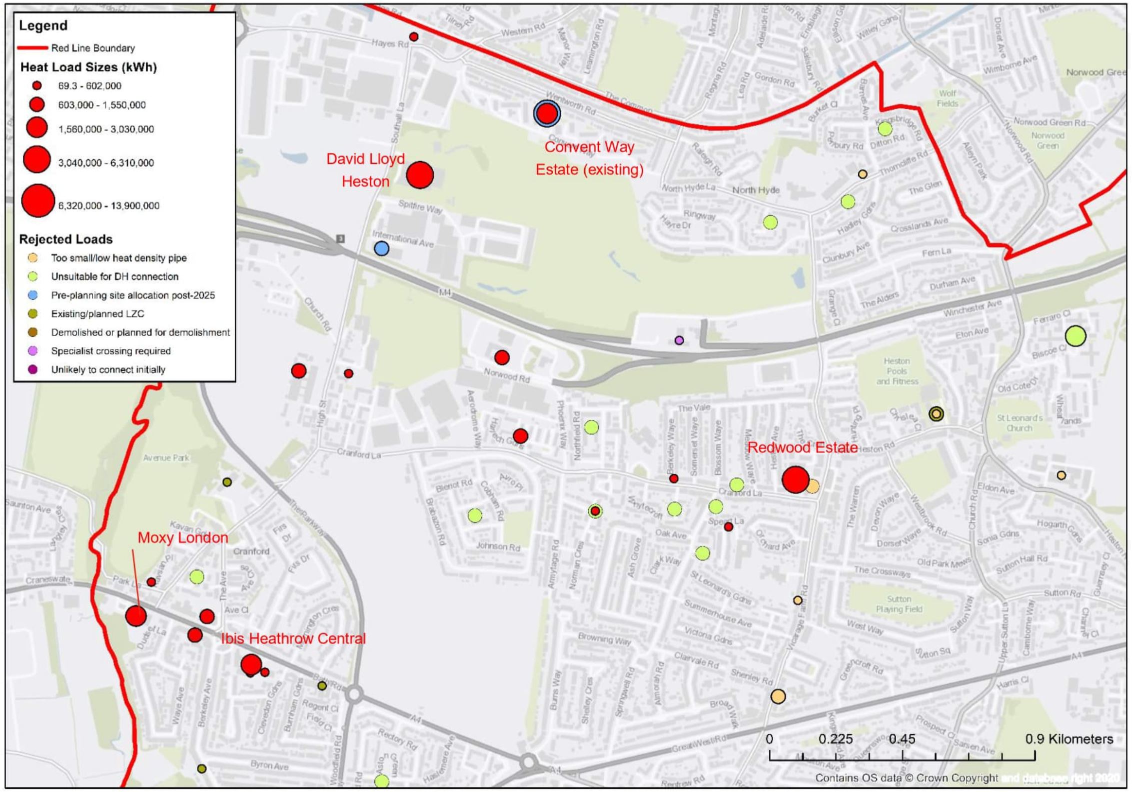

Figure 7-3: Cranford & Heston West heat demand bubble map

7.2 Energy Centre Appraisals

To harness low and zero carbon heat (LZC), generate usable heat and deliver it via the network to connected buildings, Energy Centres (ECs) are required to host the necessary plant and equipment. The size of the ECs vary with capacity (power) of heat required to be delivered. This plant can be contained within suitable existing plantrooms or newly constructed, purpose-built buildings. To minimise infrastructure, it is preferred to locate ECs close to the preferred heat source and to the network customer buildings, however aspects such as land ownership and impact on residents and ecology are also considered.

Following the methodology set out in Appendix C.5.2, AECOM carried out an assessment to identify potential EC locations, and with LBH agreed the scoring criterion to qualitatively appraise these against each other. The complete appraisals can be found in Appendix G. An overview map with the key differentiating factors is shown in Figure 7-4 with factors coloured on a RAG scale according to their impact on the appraisal score. The highest scoring, and therefore, Preferred Option has been highlighted in green. This site was used in this initial technoeconomic modelling; however, all sites (and any others discovered in future) should be considered in future design stages.

Both potential energy centres are located at the far end of the network close to potential low and zero carbon heat sources.

Hayes Road Industrial Estate is not considered to be easily deliverable as it requires the engagement of a private sector stakeholder, who would be required to sacrifice useable car park spaces, impacting businesses and customers. This option should only be considered if access to the canal is essential.

Council owned land opposite Convent Way Estate is an ideal site with access to multiple low and zero carbon heat sources. Covent Way Estate redevelopment would provide an alternative energy centre location integrated into the new site however this development has been excluded from analysis at the request of LBH. A sufficient area of 660m² GIA has been located to build a new standalone energy centre (see Appendix I for layout).

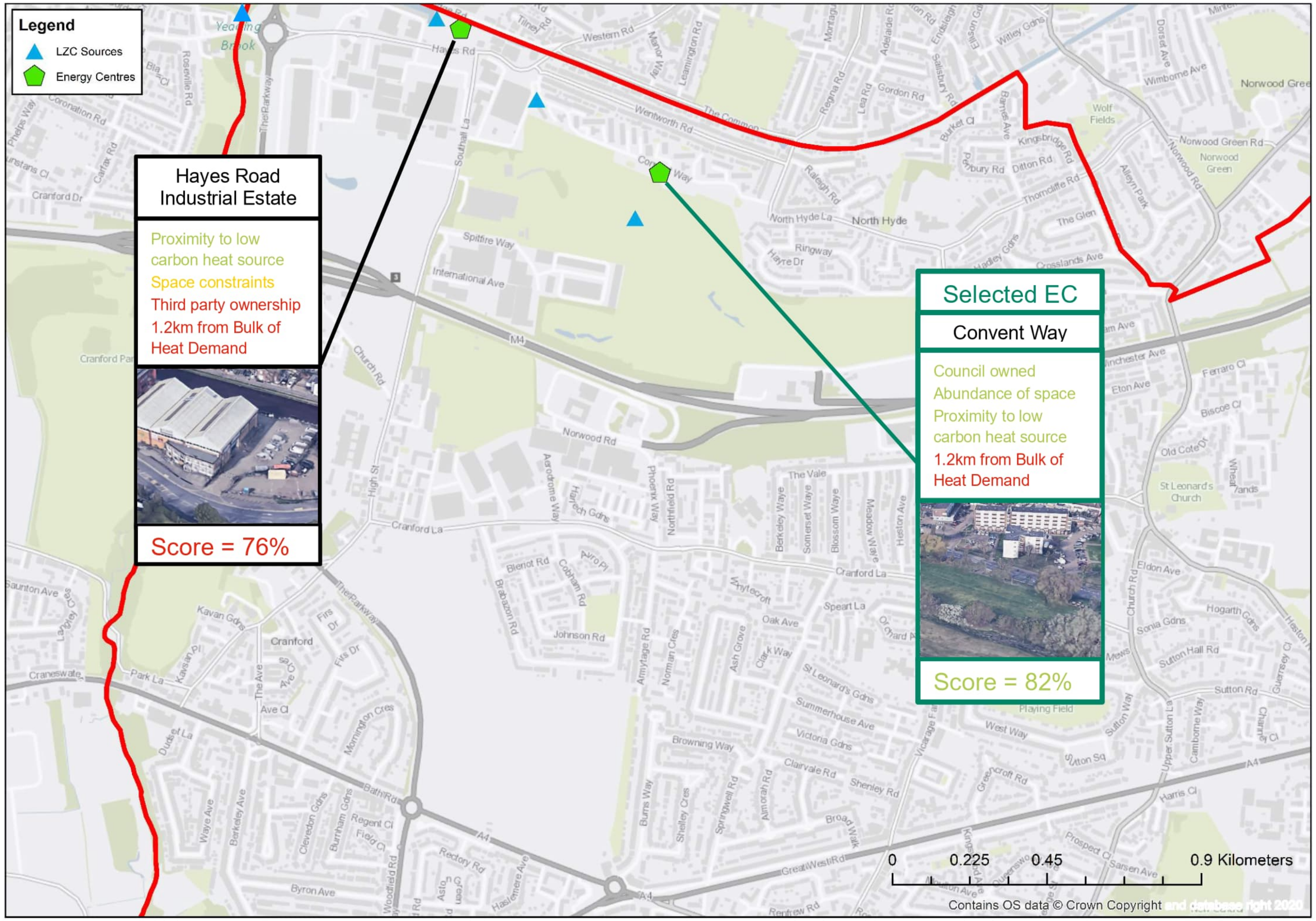

Figure 7-4: Cranford & Heston West map of potential and selected energy centres

RAG: R=Red - a low or negative scoring criteria, A=Amber – a medium or neutral scoring parameter and G=Green – a high or positive scoring parameter

7.3 Low and Zero Carbon Heat Source Appraisals

To generate low and zero (LZC) carbon heat to supply the network, a source of ambient or waste heat is typically required. If this is 'low-grade' i.e., a lower temperature than is required by the network to serve the buildings it is connected to, then an electrically fuelled heat pump is required to boost this to a usable temperature.

Following the methodology set out in Appendix C.5.1, AECOM carried out an assessment to identify LZC source and with LBH agreed a scoring criterion to qualitatively appraise these against each other. The complete appraisals can be found in Appendix J. An overview map with the key differentiating factors is shown in Figure 7-5 with factors coloured on a RAG scale according to their impact on the appraisal score. The highest scoring, and therefore, Preferred Option has been highlighted in green. This source was used in this initial technoeconomic modelling; however, all sources (and any others discovered in future) should be considered in future design stages.

Waste heat recovery from the electrical transformer heat recovery scored poorly due to the likely inability to provide the scale and consistency of supply needed to meet demand. This source is heavily dependent on agreements with third parties as well as on third party utilisation of the asset (amount of electricity transmitted through the transformer) so is not well suited as the primary source.

Air-source heat pump is a good option however this would require significant, well-ventilated space to achieve the capacity needed. This technology is also inefficient during winter when demand is highest due to low air temperatures.

Water Source at Grand Union Canal is also a good option, however, may not achieve the required flow rates to meet demand (especially in stagnant canals) and is affected similarly to ASHP in winter.

The only other option is open-loop ground source heat which is a mature technology and is a secure source of ambient heat, the efficiency of which is relatively unaffected by weather conditions. To construct the boreholes required for this technology typically requires a large area of open space, suitable for the use of a drilling rig. The area identified as the most promising is the former golf course and this was selected as the preferred heat source.

The available yield (heat capacity) from boreholes can be difficult to estimate and is typically based on historical yields of those in proximity. The preliminary hydrogeological undertaken in this study estimated that approx.60% of the required yield could be obtained, however, with modern methods, this could be up to 100%. In this initial technoeconomic modelling, it is assumed that the full required bore hole yield can be achieved. Following detailed hydrogeological studies and bore hole testing, if it is discovered that the required bole hole yield cannot be achieved, air source heat pumps are the preferred secondary option to uplift generation capacity to the required levels. See

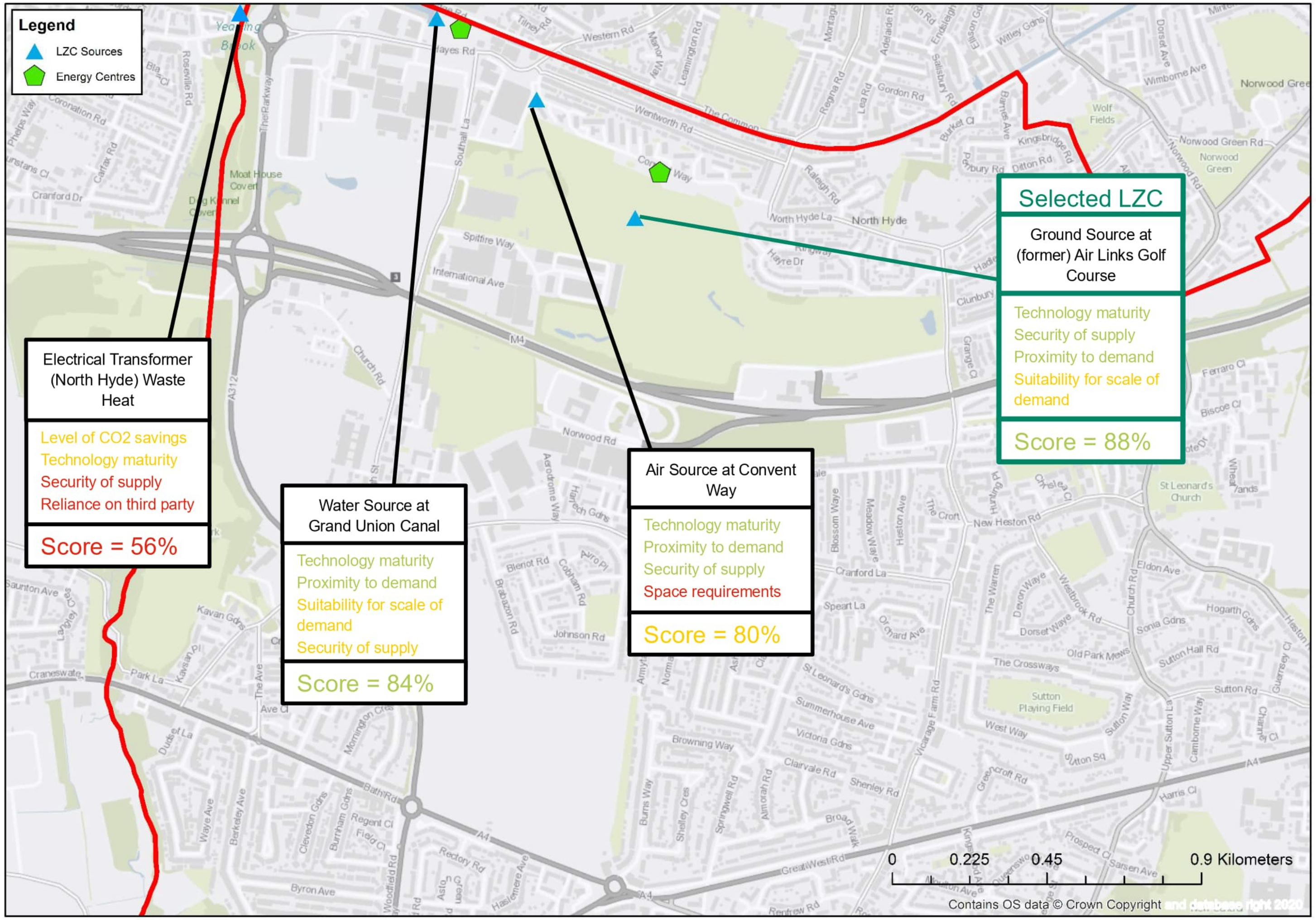

Figure 7-5: Cranford & Heston West map of potential and selected LZC sources

7.4 Distribution System

This section details the initial proposed network to deliver heat from the energy centre to the customer buildings (loads). The pipe network shown in Figure 7-6 was designed in accordance with the methodology set out in Appendix C.6.

The network design was demand driven, in that the network has maximised the number of connectable loads to maximise the potential carbon savings from the project rather than being restricted by the available heat capacity, as noted in Section 7-3. In future design stages, the network extent can be refined to a "core" network that improves technical and economic performance at a smaller scale by including only anchor loads.

The key constraints are the M4 Motorway and 2 A-road crossings. Crossing these obstructions is extremely costly and adds complexity. Analysis showed that crossing these obstructions was essential to providing a critical mass of heat demand in order to consider a heat network. The M4 specialist crossing will require particular attention in later design stages as it has been noted that directional drilling may be necessary to make this crossing (underground) without disturbance to the flow of traffic.

Pipe routing is a multi-objective optimisation problem: minimise cost and minimise distance. Different cost rates (£/m) are assigned to each section of pipe to reflect the different dig types. A dig type is a description of the type of ground in which trenches are made to install the network pipework, with more dense urban environments being more expensive than open grassed area. These cost rates use in this initial technoeconomic analysis can be found in Appendix O.2, Table 15-36, and their application on the route shown in Figure 7-6.

Cranford & Heston West is mainly urban dig type - excluding the specialist crossings since this is a more sparsely built-up area of the borough.

The constraints described above and highlighted in Figure 7-6 have been assigned a specialist crossing dig type.

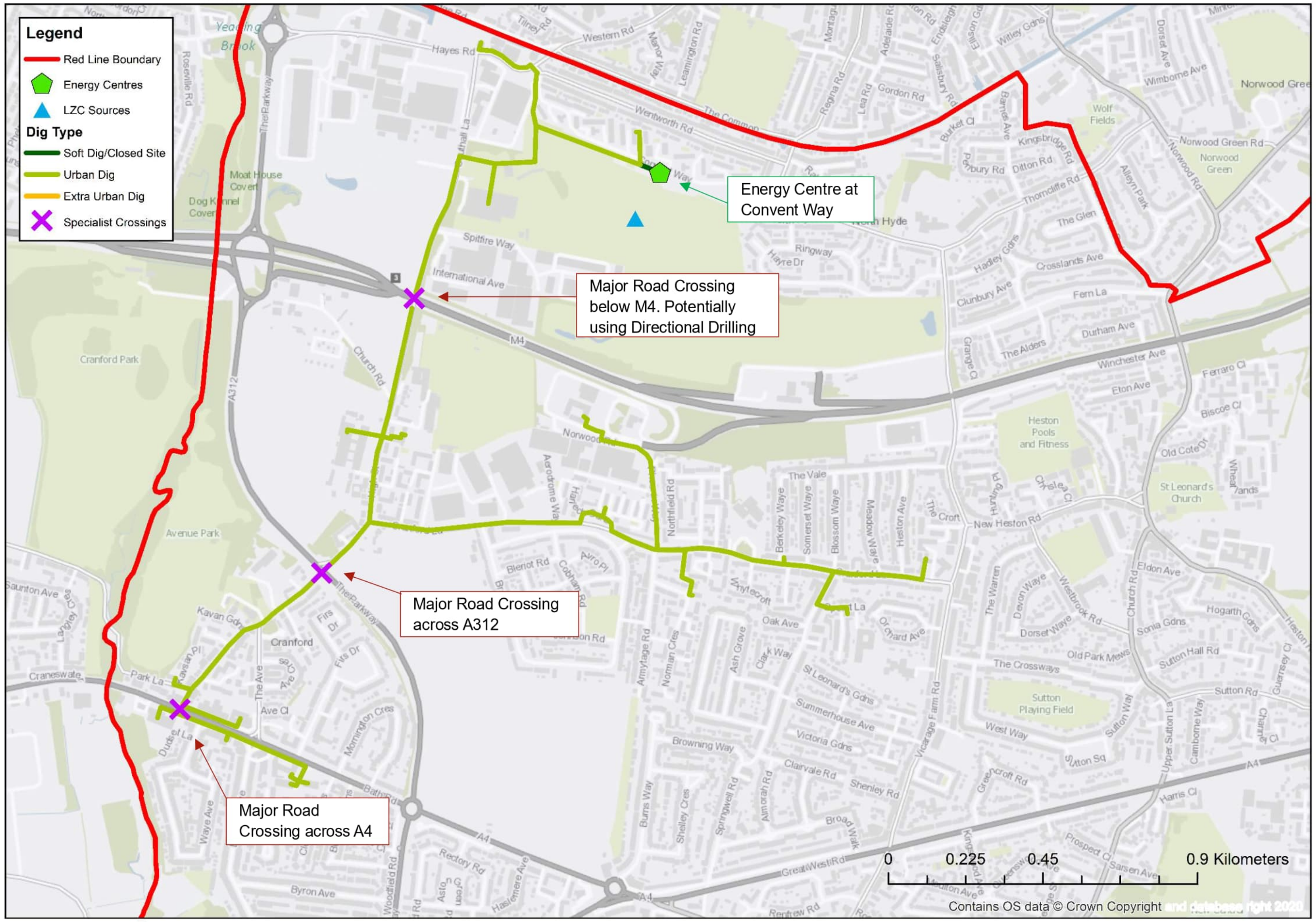

Figure 7-6: Cranford & Heston West map of distribution system, dig types and constraints

Cranford & Heston West is proposed as a heat-pump-led, third generation heating only network. A description of heat network technologies can be found in Appendix B.

A preliminary assessment of connected loads shows that ~100% currently require a ~80°C supply to provide the space heating comfort and domestic hot water requirements without fabric improvement and/or secondary side works. This is due to the age of the buildings and tendency for existing heating systems to operate on traditional 82°C/71°C temperature regimes which means these buildings are only suitable for connection to a high temperature third generation network. Connected buildings should be encouraged to undertake modifications to their buildings and systems to enable them to operate at lower temperatures without any compromise in comfort performance. If all connected buildings operated at a lower temperature the network supply temperature could be decreased becoming a fourth generation network with greater efficiency. Improved fabric should be the priority as this will also reduce consumption, but upgraded and rebalanced (optimised flow and return temperatures) heating systems should also be considered. The network has been modelled to include weather compensation to reduce operating temperatures during warmer weather when demand is lower, thereby reducing heat losses from the pipework. During winter the flow temperature is 80°C, which then reduces with increasing external air temperature, reaching a minimum of 70°C – require to generate domestic hot water in the 'worst case' connected loads. It is estimated that the network would operate at 70°C flow for over 90% the year, resulting in ~21% reduction in network losses and 16% increase in heat pump efficiency compared to a non-weather compensated network.

Steel pipework has been specified in lieu of PEX (plastic) to ensure the longevity of the infrastructure at the proposed operating temperatures and pressures.

In this initial technoeconomic modelling, the network construction commences in Q1 2027 in a single phase, achieving heat on to all loads in 2028. See high level project programme in Appendix Q. This programme will depend on the timeline for the subsequent design stages, the heat customer required connection dates and the availability of contractor resource to construct the network and their rate of install. It is possible that the preferred solution is found to be a phased installation of the network. These details are to be developed in future design stages, and upon completion of enhanced stakeholder engagement.

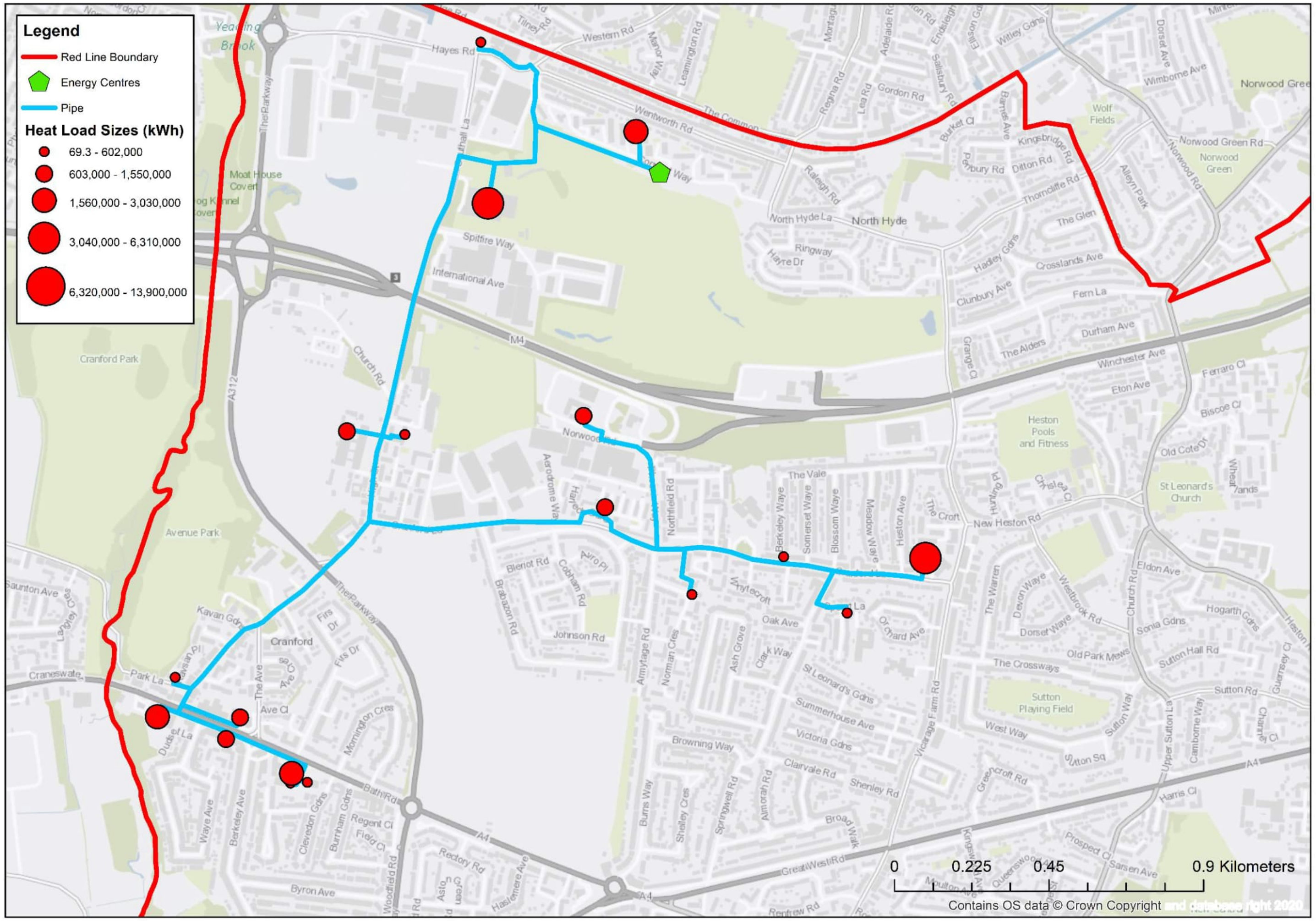

Figure 7-7: Cranford & Heston West map of distribution system and connected loads

7.5 TEM Outputs

The above-described design for a district heating network has been analysed, to assess the performance of the solution against LBH environmental and economic aspirations. The methodology for techno-economic modelling is described in Appendix C.7 and the key modelling assumptions are detailed in Appendix O.

7.5.1 Generation Plant Specification

The generation plant detailed in Table 7-3 was determined through the initial technoeconomic modelling to achieve the target carbon intensity of heat of 100gCO2e/kWh (aligned with GHNF gated metrics and agreed with LBH) whilst satisfying the network demand with an economic plant composition and space efficient energy centre.

Attribute	Quantity
Energy Centre Internal Floor Area	660m²
Ground Source Heat Pump	2No. 1,200kW = 2,400kW
Heat Pump Refrigerant	Ammonia
Peaking and Resilient Gas Boiler	4No. 2,650kW = 10,600kW
Thermal Storage	128m³
Electrical Connection	1.2MVA

Table 7-3: Cranford & Heston West generation plant specification

Initial design of the energy centre has been completed and is included in Appendix I. An application and budget request for a new electrical connection at the energy centre has been made to Scottish and Southern Electricity Network (SSEN), details of which can be found in Appendix L. The resultant budget quotes were formed without conducting grid analysis and therefore do not reflect potential grid reinforcement charges. The mitigate the risk of the cost in the formal quotation being higher than the budget figure, the cost of connection used in this initial technoeconomic analysis is based on previous projects rather than the quoted figures, however it is critical that these are reviewed in future design stages. The electrical grid is extremely constrained in West London, including Hounslow[35]. The GLA have warned significant new connection applications will not be approved until after 2035 once the grid can be reinforced. As such there is a risk that the 1.2MVA supply required for the energy centre may not be possible until that time.

7.5.2 Distribution System Specification

The key design metrics for the distribution system, as described in section 7.4 in demonstrated in Table 7-4 below:

Attribute	Quantity
Network Length	7,027m
Linear Heat Density	3,506 kWh/m
Flow/Return Temperatures	70-80°C / 40-50°C
Thermal Losses	

Table 7-4: Cranford & Heston West distribution system specification

7.5.3 Environmental Performance

Table 7-5 demonstrates the environmental performance of the network solution in respective to carbon savings.

Parameter	Quantity
40-year Cumulative Carbon Savings vs Gas Boilers (tCO_2e)	137 ktCO2e
40-year Cumulative Carbon Savings vs Gas Boilers (%)	70.0%
Year 1 Carbon Intensity of Heat (gCO_2e/kWh)	100 gCO2e/kWh

Table 7-5: Cranford & Heston West environmental performance

7.5.4 Economic Results & Optimisation

The base case techno-economic modelling results include no grant funding, a connection fee domestic) and a heat tariff equal to the counterfactual cost (this is assessed for each load individually, however, the **average** non-domestic tariff is shown below in Table 5-6 and the **average** domestic tariff is shown below in Table 5-7 as an indicator).

1. Grant Funding e.g., from the Green Heat Network Fund[36]
2. Increase in connection charge for non-domestic customers[37]
3. Increase in tariff for domestic customers

Fixed results (i.e., independent of the 3 revenue source variations detailed above) are shown in Table 7-6.

Parameter	Quantity
Heat Generation CapEx (£'mill)	
Distribution CapEx (£'mill)	
Total CapEx[38] (£'mill)	
Annual OpEx (£)	
Avg. Non-domestic tariff (p/kWh)	
Counterfactual Levelised Cost of Heat[39] (p/kWh)	

Table 7-6: Cranford & Heston West fixed economic results

	Optimisation Scenario	Base case	Max grant	Max grant + increased commercial connection	Max grant + increased commercial connection 2	Max Grant + increased domestic tariff
Optimisations	Grant funding (% of CapEx)					
	Non-domestic connection fee (£/kW)					
	Avg. Domestic tariff (p/kWh)					
Results	IRR 40-year (%)					
	Levelised Cost of Heat (p/kWh)					
	Social IRR 40-year (%)					

Table 7-7: Cranford & Heston West optimisation results

Note: Optimisations have been highlighted red where the value differs from the base case.

[35] London Housing Development Faces Delays to 2035 on Electricity Capacity - Bloomberg
[36] The upper limit of this was determined by applying GHNF guidance

[39] Counterfactual Levelised Cost of Heat across all domestic and non-domestic with GHNF aligned mixture of gas boiler and ASHP counterfactuals, respectfully. Value levelised using a discount rate of 3.5%. This value is NOT equal to the heat tariff. The heat tariff is equal to the non-levelised counterfactual cost for a single load assessed for each load individually. Counterfactual LCoH is used as comparison to the scheme LCoH only.

7.5.4.1 Domestic Tariff Impact

Unlike all other clusters the domestic loads do not have a negative impact on the network economic performance. This is because Cranford & Heston West has a large proportion of individual dwelling domestic loads which have a higher cost counterfactual. Since the tariff for each customer is set equal to the counterfactual cost of that load, this raises the average domestic heat tariff on the network. Note: 2 of 4 domestic loads on the network do have a negative impact on the network economic performance, due to low tariffs, however the average domestic load is beneficial.

7.5.4.2 Sensitivity Analysis

In line with HNDU requirements, the impact of several key sensitivities were analysed, the results of which are demonstrated in Table 7-8.

Sensitivity	Variation	40-year pre-tax IRR
Generation and Supply CapEx		
Distribution CapEx		
Variable element of fuel input prices (electricity, gas, and waste heat)		
Variable element of energy sales tariffs for heat concurrent with variable element of fuel input prices (electricity, gas, and waste heat)		
Discount % against the counterfactual of the variable element of heat sales tariffs		
Heat demand usage change (loss of customers, gain of customers or building fabric efficiency savings)		
Effect of a significant reduction in availability of LZC or loss of waste heat source		
Heat network losses (primary/secondary)		
(		

Table 7-8: Cranford & Heston West HNDU sensitivities

In addition to those stated above, a project specific sensitivity was also undertaken in relation to connection to social housing loads. In the core analysis, social housing loads which were fed from an existing communal heating system were included in the network. The core analysis also included some loads which were fed from individual systems (e.g. gas combi boilers in each unit). For the network to connect to the latter would require communal conversion at a greater cost and at greater complexity than to an existing communal system. Communal conversion will require funding outside the scope of this project.

In Cranford & Heston West, Convent Way Estate and Harlech Gardens Estate were identified as individual dwelling systems that are suitable for communal conversion and was included in the core analysis. In the event these conversion works are not carried out and the load is not included in the network, th

7.6 Summary

7.6.1 Key Risks

- The 1.2MVA supply required for the energy centre may not be possible until after 2035 due to grid constraints. It is possible that the cost of grid reinforcements may be higher than modelled and reduce the economic performance of the network.
- The yield from the aquifer bore hole may not achieve the required 36l/s and would need to be supplemented by another low carbon heat source or the network extent reduced.

See Appendix R for risk register.

7.6.2 Opportunities

- Link decarbonisation of area to convent way estate regeneration.

See Appendix R for HNDU opportunities matrix.

7.6.3 Customer

Cranford & Heston West has the lowest heat demand and with a small number of large loads which are not densely gathered, meaning a significant amount of network infrastructure is required to connect customers. However, 68% of the loads are council owned which reduces the risk of loss of customers.

7.6.4 Engineering Solution

The high-level hydrogeology study estimated that a ground borehole yield of 60% flowrate of the aspiration would be probable, albeit further investigation is required. A reduction in yield could be accommodated by reducing the network extent or by supplementing with another technology such as an air source heat pump. With the desire of LBH to decarbonise the borough, supplementing with ASHP would be the preferable option in order to meet decarbonisation targets.

There are a number of major roads which represent significant physical barriers to the proposed network. The largest of these, the M4, would likely require a specialist crossing to be installed below the motorway to prevent closures for excavation. If this cannot be achieved, or is too expensive to complete, the network would be blocked from expanding south and would be unable to reach the vast majority of proposed loads.

This network is considered to be highly technically difficult largely due to the major barriers to the network, but also limitations of low carbon heat capacity to serve the proposed customers and the requirement to obtain approval for drilling and use of boreholes on the golf course

7.6.5 Economic & Environmental

The network CapEx c[redacted]CO_2e over 40 years. This is a considerable carbon saving of 137 ktonnesCO2e over 40 years, which is equivalent to:

217,288

A round-trip economy ticket holder flying LHR -> JFK ->LHR (11,000km total) 217,288 times[40]

0.4% & 1.0%

0.4% of Hounslow’s 40-year borough wide emissions and 1.0% of Hounslow’s 40-year borough wide emissions from gas [41]

155,682

The carbon dioxide 155,682 mature tree’s remove from the atmosphere in the same 40 years[42].

[40] International Civil Aviation Organisation ICAO Carbon Emissions Calculator
[41] London Borough of Hounslow Climate and Clean Air Annual Report 2021, 2019 data extrapolated over 40 years
[42] Tree Carbon Benefit -European Environment Agency

8. Feltham

8.1 Energy Demand & Mapping

8.1.1 Heat Demand

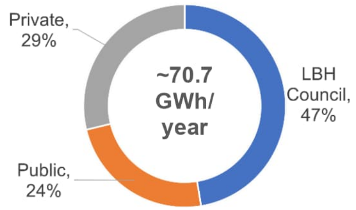

Figure 8-1: Feltham ownership of heat demand

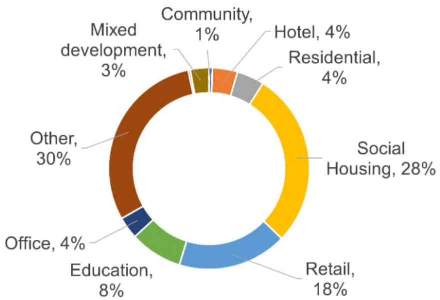

Figure 8-2 Feltham use type of heat demand

Undiversified (MW)	Diversified (MW)	Diversity
32.9	28.1	0.86

Table 8-1: Feltham network peak demand metrics

Note: see appendix C.3 for explanation of diversity.

ID	Load Name	Ownership	Annual Heat Demand (MWh)
250	HMP/YOI Feltham	Public	13,453
323	The Longford Centre: "The Centre"	Private	6,309
332	Waterloo Estate	Local Authority	4,516
285	Oriel Estate (blocks)	Local Authority	3,922
311	St. Giles Hotel	Private	2,860

Table 8-2: Feltham anchor loads

Figure 8-3 shows the 153 loads that have been identified in Feltham, with the size of the circle indicating the scale of their heat demand. 72 of these 153 loads have been included in the proposed district heat network with the others qualitatively omitted for the reasons indicated in the Figure Legend, which includes: unsuitability of the load to connect to district heating (e.g., no communal system), existing use of a low carbon heat source, request from LBH to exclude pre-planning site allocations (possible future developments) post-2025 and requirement to make specialist crossing of an obstruction, e.g., railway. Excluded loads can be found in Appendix D.

This cluster has very dense heat demand, however 2 of the largest loads are at the extremities of the cluster and the location of load is not linear which is not optimal for network design. 47% of the demand is from council owned loads. LBH has direct control over whether these buildings choose to connect to the network. Public sector buildings (which account for 24% of load) are next preferred due to the prevalent desire to achieve net-zero ambitions, followed by private sector which carry the highest risk of not choosing to connect. The planned introduction of Heat Network Zoning offers a potential means to reduce the risk of key loads choosing not to connect through its proposed mandating of specific sites to connect to a network within a zone where this is the lowest cost decarbonisation solution.

There are several social housing estates that have been excluded from consideration as they are currently not supplied from a communal heat system and so require significant secondary side works to connect to district heating. These loads could undergo the required communal conversion of secondary systems and should be investigated in future, however; most have been excluded from this initial analysis. 1No. communal conversion has been recommended, see Section 8.5.4.2 for sensitivity analysis of inclusion of this load.

The methodology for energy demand analysis and mapping is set out in Appendix C.3 & C.4. In addition to heating loads demonstrated here, electrical & cooling loads have also been mapped and can be found in Appendix F. Due to the higher carbon savings provide by heat networks (replacing gas) compared to cooling networks (replacing electrically driven air-source heat pumps), the preferred network solution is heating only.

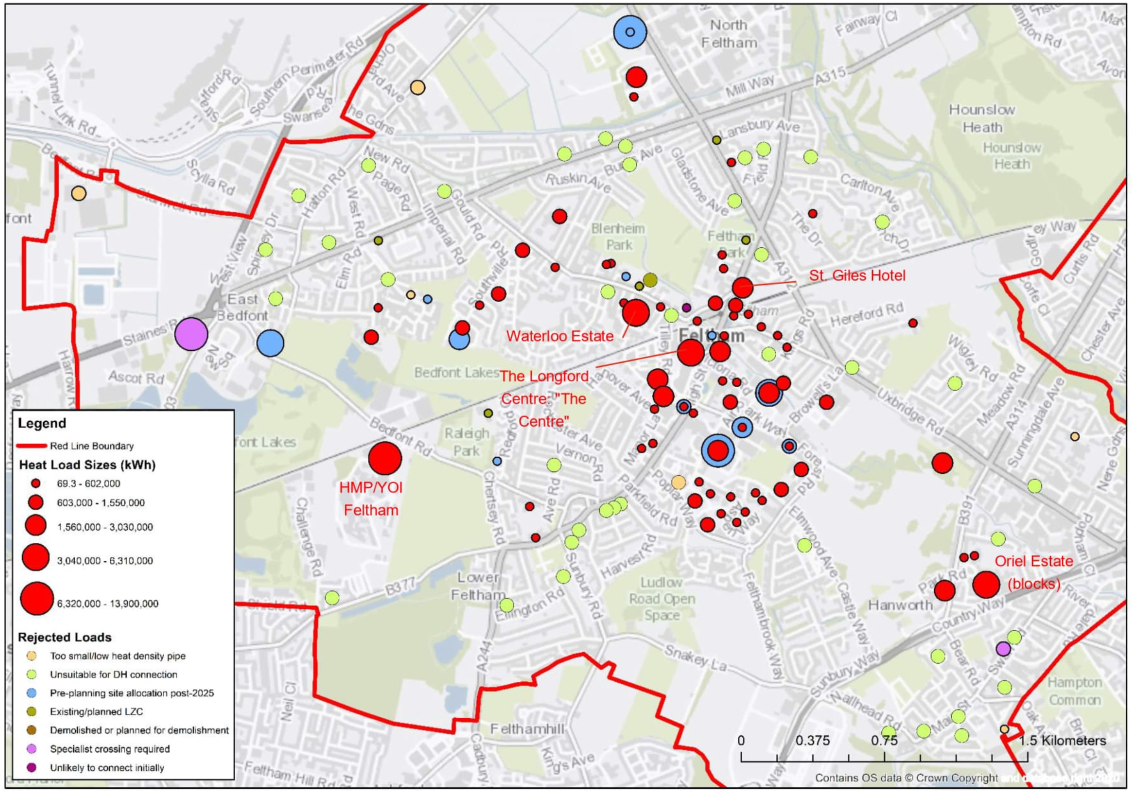

Figure 8-3: Feltham heat demand bubble map

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Following the methodology set out in Appendix C.5.2, AECOM carried out an assessment to identify potential EC locations, and with LBH agreed the scoring criterion to qualitatively appraise these against each other. The complete appraisals can be found in Appendix G. An overview map with the key differentiating factors is shown in Figure 8-4 with factors coloured on a RAG scale according to their impact on the appraisal score. The highest scoring, and therefore, Preferred Option has been highlighted in green. This site was used in this initial technoeconomic modelling; however, all sites (and any others discovered in future) should be considered in future design stages.

HMP YOI Feltham would provide a sufficient public sector owned site with good access to low and zero carbon energy sources, however, the secure nature of the site means programme implications can be foreseen and more importantly the site is a significant distance from the bulk of loads which will lead to larger pipes required, greater costs and more losses.

Leisure west is ideal in terms of proximity to demand however would only be suitable for an air source heat pump lead network. The private ownership of this site leads to a complicated delivery especially given the loss of parking spaces and therefore loss of custom for businesses.

A sufficient area of 960m² GIA has been located at Springwest Academy to build a new standalone energy centre (see Appendix I for layout). The site is council owned but on lease to the academy. A positive response from Springwest Academy would be needed to realise this solution which is unlikely given the disturbance to students. Feltham currently lacks a strong energy centre site for a standalone network.

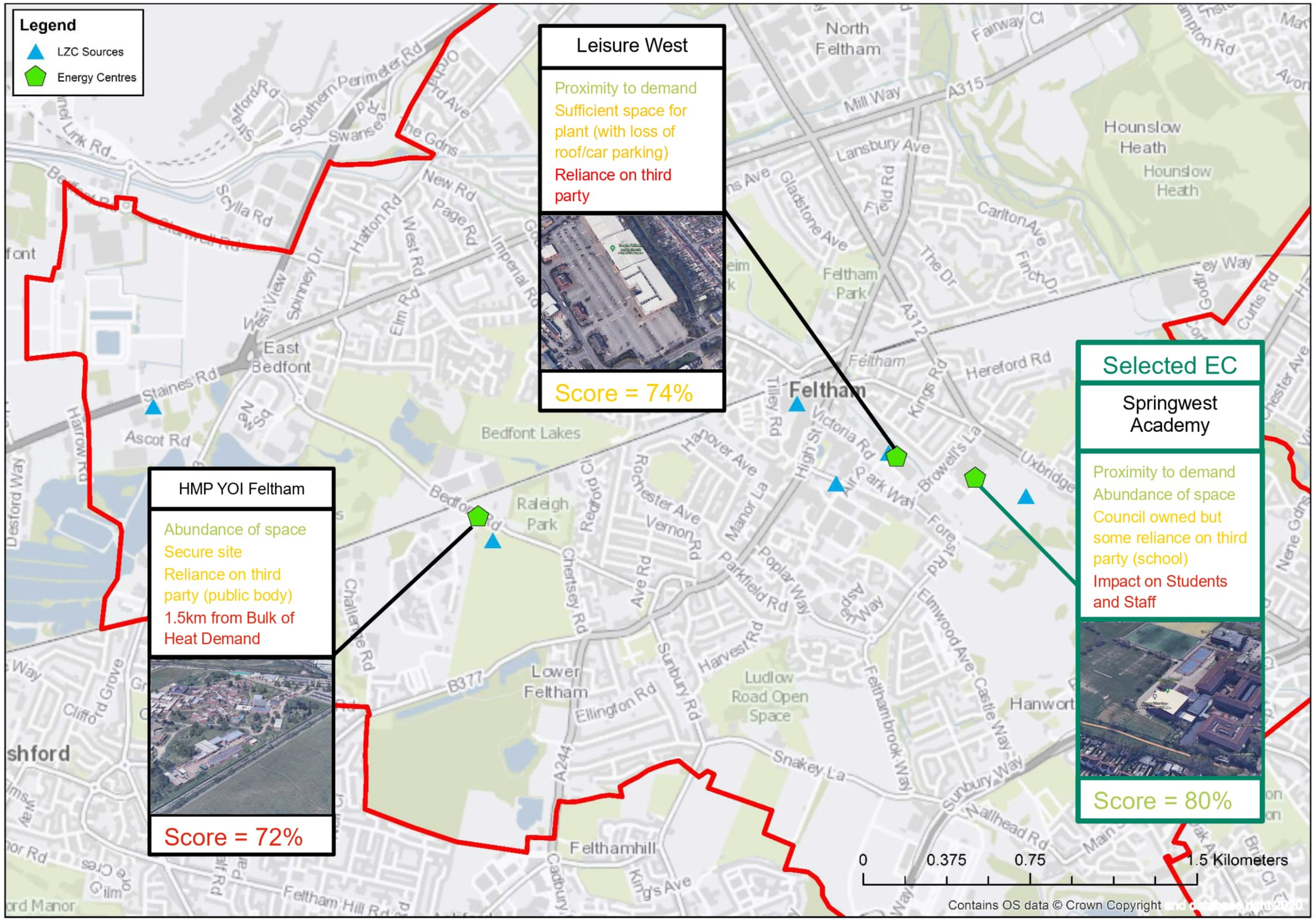

Figure 8-4: Feltham map of potential and selected energy centres

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8.3 Low and Zero Carbon Heat Source Appraisals

To generate low and zero (LZC) carbon heat to supply the network, a source of ambient or waste heat is typically required. If this is 'low-grade' i.e., a lower temperature than is required by the network to serve the buildings it is connected to, then an electrically fuelled heat pump is required to boost this to a usable temperature.

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Waste heat recovery from Asda cooling, the data centre and electrical transformer heat recovery scored poorly due to the likely inability to provide the scale and consistency of supply needed to meet demand. These sources are heavily dependent on agreements with third parties as well as on third party utilisation of the asset (use of cooling in the supermarket and data centre, amount of electricity transmitted through the transformer) so are not well suited as the primary source.

Air-source heat pump is a good option however this would require significant, well-ventilated space to achieve the capacity needed. This technology is also inefficient during winter when demand is highest due to low air temperatures.

The remaining 2 options are open-loop ground source heat which is a mature technology and is a secure source of ambient heat, the efficiency of which is relatively unaffected by weather conditions. To construct the boreholes required for this technology typically requires a large area of open space, suitable for the use of a drilling rig. The areas identified as the most promising are relatively close to each other and will likely provide similar flowrates. As such, proximity to the preferred EC is the main consideration, which meant Hanworth Park was selected as the preferred location.

The available yield (heat capacity) from boreholes can be difficult to estimate and is typically based on historical yields of those in proximity. The preliminary hydrogeological undertaken in this study estimated that less than 50% of the required yield could be obtained. In this initial technoeconomic modelling, it is assumed that the full required bore hole yield can be achieved. Following detailed hydrogeological studies and bore hole testing, if it is discovered that the required bole hole yield cannot be achieved, air source heat pumps are the preferred secondary option to uplift generation capacity to the required levels. See Appendix K for hydrogeological assessment.

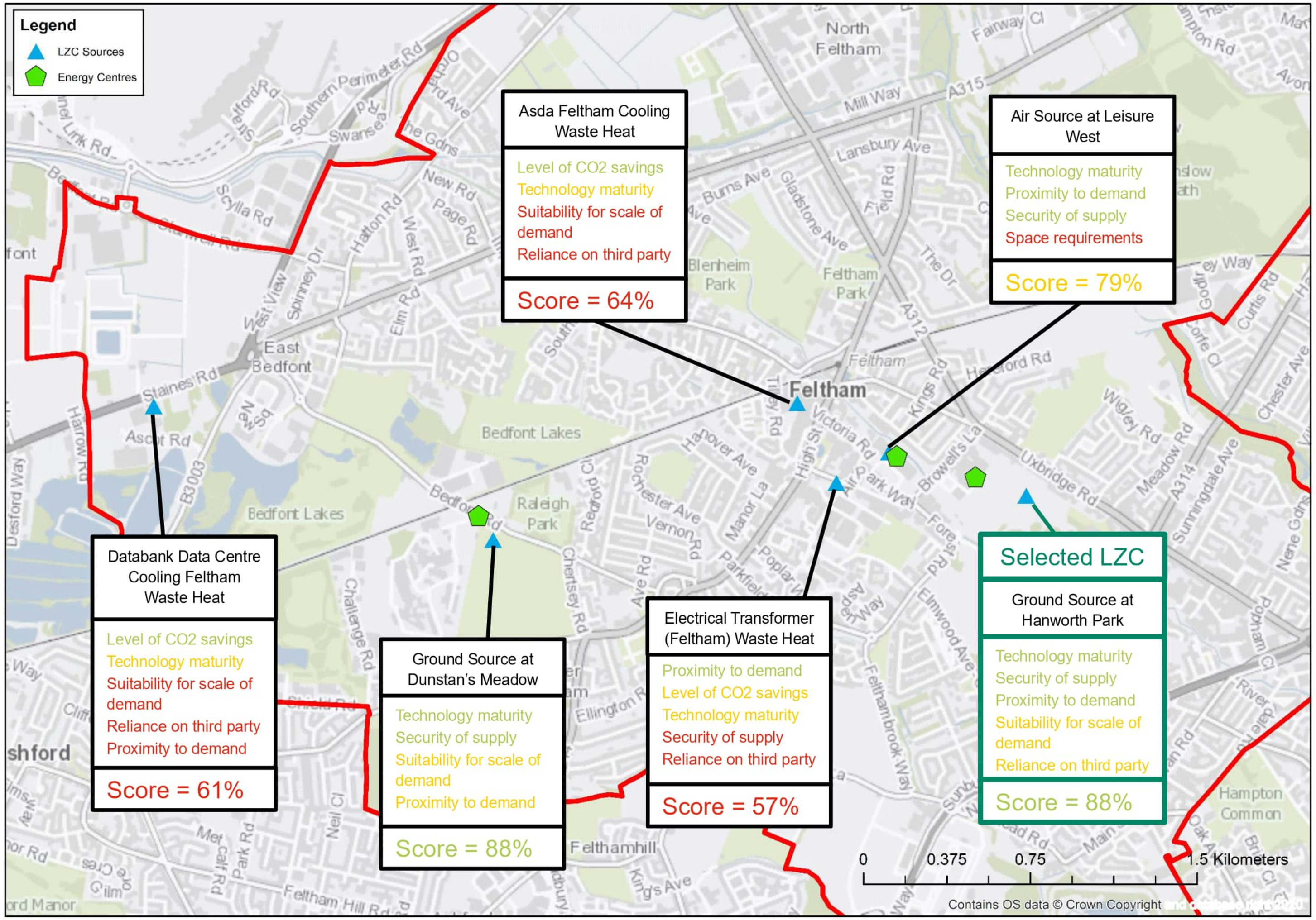

Figure 8-5: Feltham map of potential and selected LZC sources

8.4 Distribution System

This section details the initial proposed network to deliver heat from the energy centre to the customer buildings (loads). The pipe network shown in Figure 8-6 was designed in accordance with the methodology set out in Appendix C.6.

The network design was demand driven, in that the network has maximised the number of connectable loads to maximise the potential carbon savings from the project rather than being restricted by the available heat capacity, as noted in Section 8-3. In future design stages, the network extent can be refined to a “core” network that improves technical and economic performance at a smaller scale by including only anchor loads.

The key constraints are the overground railway through the centre, the Longford River and the Duke of Northumberland’s River. Both rivers are minor and significant costs and programme delays are not foreseen. Crossing the railway is extremely costly and adds complexity. The design decision has been made to cross all required constraints, however at later design stages each will undergo detailed costing to refine this decision.

Pipe routing is a multi-objective optimisation problem: minimise cost and minimise distance. Different cost rates (£/m) are assigned to each section of pipe to reflect the different dig types. A dig type is a description of the type of ground in which trenches are made to install the network pipework, with more dense urban environments being more expensive than open grassed area. These cost rates use in this initial technoeconomic analysis can be found in Appendix O.2, Table 15-36, and their application on the route shown in Figure 8-6.

Feltham is mainly urban dig type, with extra-urban dig types used along the A312. Where possible back roads have been used to avoid traffic disruptions during construction. The clustered location of loads within the town adds significant pipe length in order to access loads compared to linear networks.

4 specialist crossings have been identified. 3 minor river crossings and 1 overground rail crossing are specified as specialist shown in Figure 8-6.

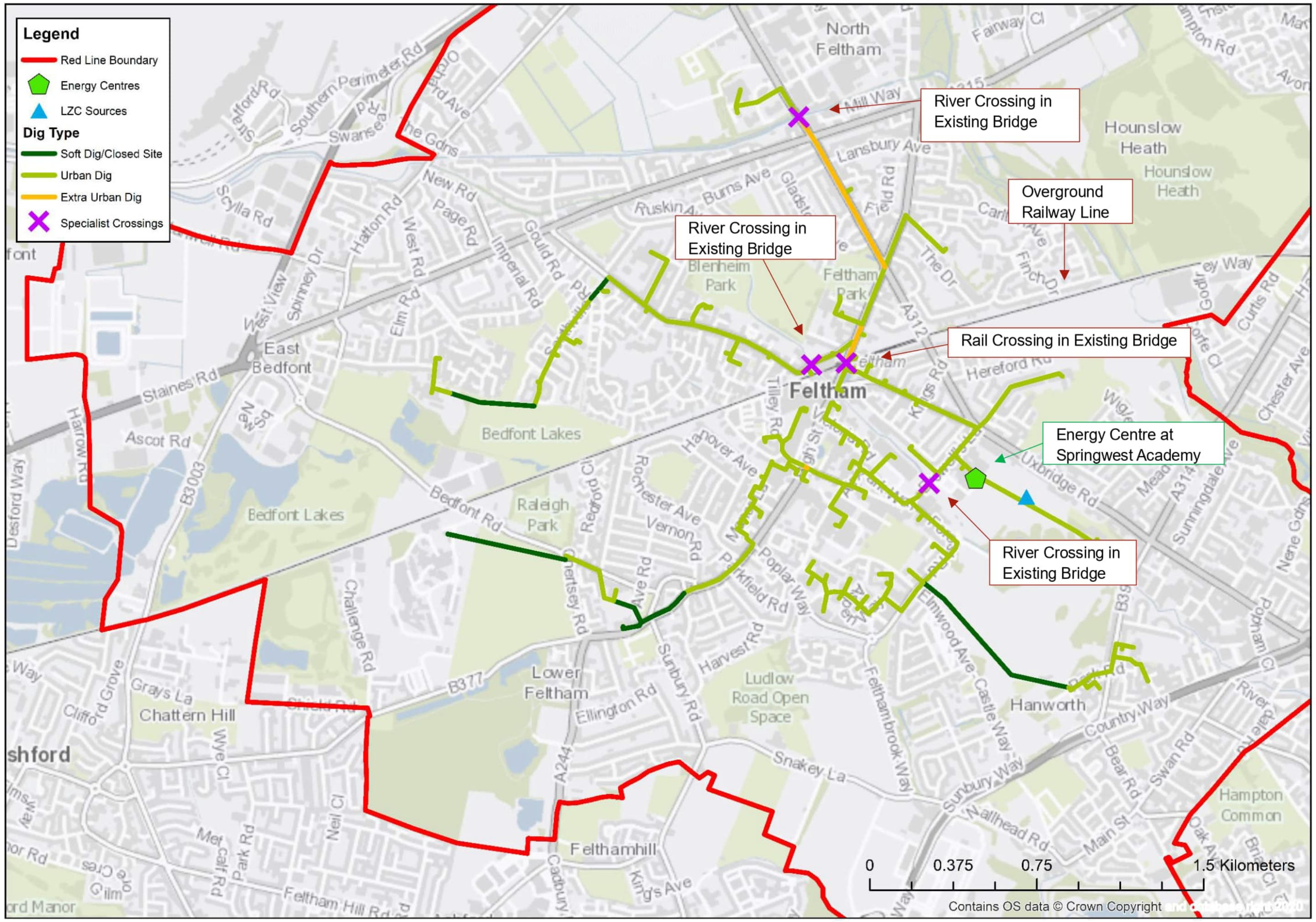

Figure 8-6: Feltham map of distribution system, dig types and constraints

Feltham is proposed as a heat-pump-led, third generation heating only network. A description of heat network technologies can be found in Appendix B.

A preliminary assessment of connected loads shows that ~81% currently require a ~80°C supply to provide the space heating comfort and domestic hot water requirements without fabric improvement and/or secondary side works. This is due to the age of the buildings and tendency for existing heating systems to operate on traditional 82°C/71°C temperature regimes which means these buildings are only suitable for connection to a high temperature third generation network. Connected buildings should be encouraged to undertake modifications to their buildings and systems to enable them to operate at lower temperatures without any compromise in comfort performance. If all connected buildings operated at a lower temperature the network supply temperature could be decreased becoming a fourth generation network with greater efficiency. Improved fabric should be the priority as this will also reduce consumption, but upgraded and rebalanced (optimised flow and return temperatures) heating systems should also be considered. The network has been modelled to include weather compensation to reduce operating temperatures during warmer weather when demand is lower, thereby reducing heat losses from the pipework. During winter the flow temperature is 80°C, which then reduces with increasing external air temperature, reaching a minimum of 70°C – require to generate domestic hot water in the 'worst case' connected loads. It is estimated that the network would operate at 70°C flow for over 90% the year, resulting in ~21% reduction in network losses and 16% increase in heat pump efficiency compared to a non-weather compensated network.

Steel pipework has been specified in lieu of PEX (plastic) to ensure the longevity of the infrastructure at the proposed operating temperatures and pressures.

In this initial technoeconomic modelling, the network construction commences in Q1 2027 in a single phase, achieving heat on to all loads in 2028. See high level project programme in Appendix Q. This programme will depend on the timeline for the subsequent design stages, the heat customer required connection dates and the availability of contractor resource to construct the network and their rate of install. It is possible that the preferred solution is found to be a phased installation of the network. These details are to be developed in future design stages, and upon completion of enhanced stakeholder engagement.

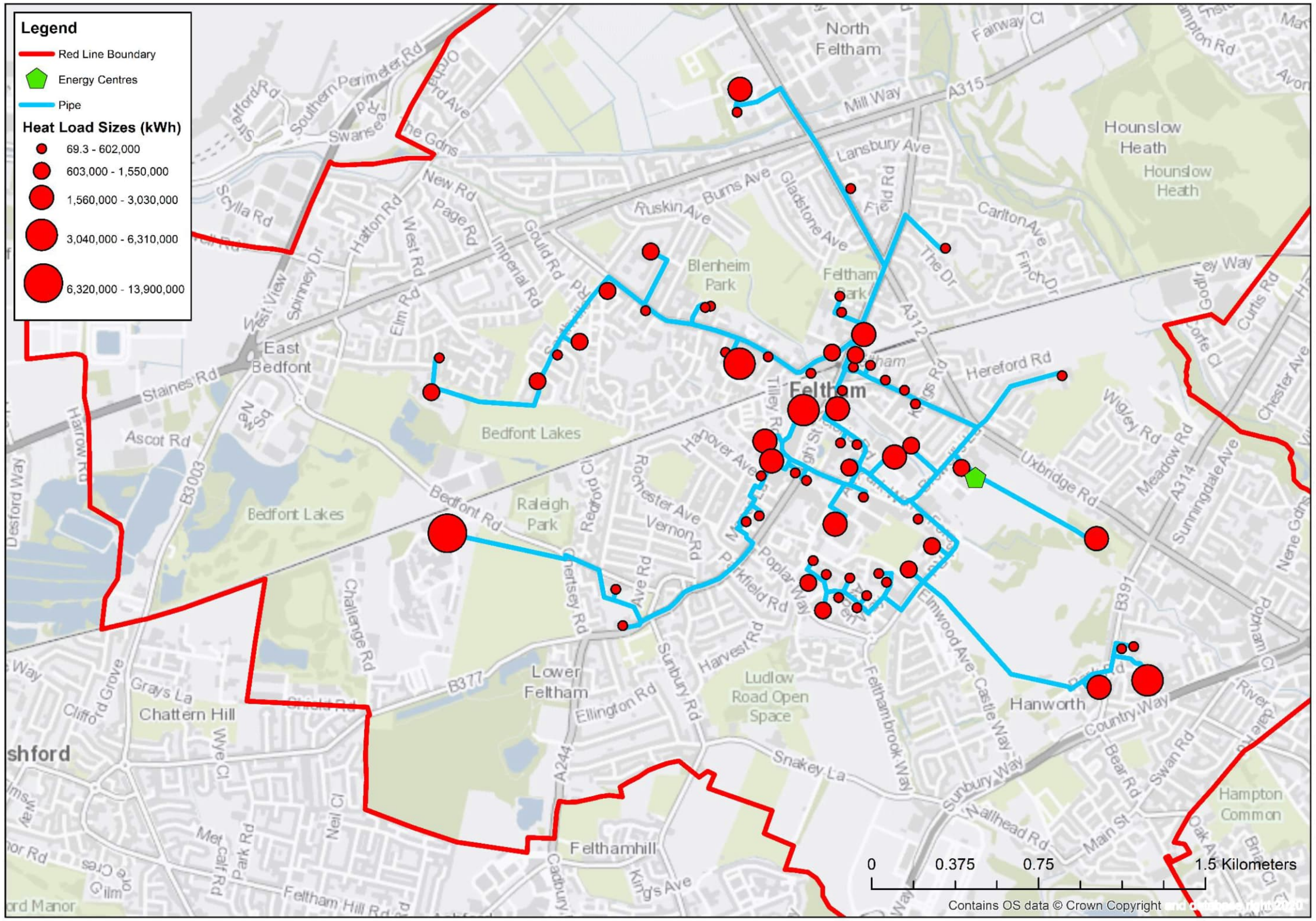

Figure 8-7: Feltham map of distribution system and connected loads

8.5 TEM Outputs

The above-described design for a district heating network has been analysed, to assess the performance of the solution against LBH environmental and economic aspirations. The methodology for techno-economic modelling is described in Appendix C.7 and the key modelling assumptions are detailed in Appendix O.

8.5.1 Generation Plant Specification

The generation plant detailed in Table 8-3 was determined through the initial technoeconomic modelling to achieve the target carbon intensity of heat of 100gCO2e/kWh (aligned with GHNF gated metrics and agreed with LBH) whilst satisfying the network demand with an economic plant composition and space efficient energy centre.

Attribute	Quantity
Energy Centre Internal Floor Area	960m²
Ground Source Heat Pump	2No. 3,500kW = 7,000kW
Heat Pump Refrigerant	Ammonia
Peaking and Resilient Gas Boiler	4No. 7,175kW = 28,700kW
Thermal Storage	340m³
Electrical Connection	3.8MVA

Table 8-3: Feltham generation plant specification

Initial design of the energy centre has been completed and is included in Appendix I. An application and budget request for a new electrical connection at the energy centre has been made to Scottish and Southern Electricity Network (SSEN), details of which can be found in Appendix L. The resultant budget quotes were formed without conducting grid analysis and therefore do not reflect potential grid reinforcement charges. The mitigate the risk of the cost in the formal quotation being higher than the budget figure, the cost of connection used in this initial technoeconomic analysis is based on previous projects rather than the quoted figures, however it is critical that these are reviewed in future design stages. The electrical grid is extremely constrained in West London, including Hounslow[43]. The GLA have warned significant new connection applications will not be approved until after 2035 once the grid can be reinforced. As such there is a risk that the 3.8MVA supply required for the energy centre may not be possible until that time.

8.5.2 Distribution System Specification

The key design metrics for the distribution system, as described in section 8.4 in demonstrated in Table 8-4 below:

Attribute	Quantity
Network Length	17,510m
Linear Heat Density	3,955 kWh/m
Flow/Return Temperatures	70-80°C / 40-50°C
Thermal Losses	[redacted]

Table 8-4: Feltham distribution system specification

8.5.3 Environmental Performance

Table 8-5 demonstrates the environmental performance of the network solution in respective to carbon savings.

Parameter	Quantity
40-year Cumulative Carbon Savings vs Gas Boilers (tCO_2e)	202 ktCO2e
40-year Cumulative Carbon Savings vs Gas Boilers (%)	71.3%
Year 1 Carbon Intensity of Heat (gCO_2e/kWh)	98 gCO2e/kWh

Table 8-5: Feltham environmental performance

8.5.4 Economic Results & Optimisation

[redacted] non-domestic tariff is shown below in Table 5-6 and the **average** domestic tariff is shown below in Table 5-7 as an indicator). Optimisations are made to the parameters of three revenue sources to assess the requirements to achieve the target IRR of [redacted]

1. Grant Funding e.g., from the Green Heat Network Fund[44]
2. Increase in connection charge for non-domestic customers[45]
3. Increase in tariff for domestic customers

Fixed results (i.e., independent of the 3 revenue source variations detailed above) are shown in Table 8-6.

Parameter	Quantity
Heat Generation CapEx (£'mill)	[redacted]
Distribution CapEx (£'mill)	
Total CapEx[46] (£'mill)	
Annual OpEx (£)	
Avg. Non-domestic tariff (p/kWh)	
Counterfactual Levelised Cost of Heat[47] (p/kWh)	

Table 8-6. Feltham fixed economic results

	Optimisation Scenario	Base case	Max grant	Max grant + increased commercial connection	Max grant + increased commercial connection 2	Max Grant + increased domestic tariff
Optimisations	Grant funding (% of CapEx)	[redacted]				
	Non-domestic connection fee (£/kW)					
	Avg. Domestic tariff (p/kWh)					
Results	IRR 40-year (%)					
	Levelised Cost of Heat (p/kWh)					
	Social IRR 40-year (%)					

Table 8-7: Feltham optimisation results

Note: Optimisations have been highlighted red where the value differs from the base case.

[43] London Housing Development Faces Delays to 2035 on Electricity Capacity - Bloomberg
[44] The upper limit of this was determined by applying GHNF guidance [redacted]

[47] Counterfactual Levelised Cost of Heat across all domestic and non-domestic with GHNF aligned mixture of gas boiler and ASHP counterfactuals, respectfully. Value levelised using a discount rate of 3.5%. This value is NOT equal to the heat tariff. The heat tariff is equal to the non-levelised counterfactual cost for a single load assessed for each load individually. Counterfactual LCoH is used as comparison to the scheme LCoH only.

8.5.4.1 Domestic Tariff Impact

8.5.4.2 Sensitivity Analysis

In line with HNDU requirements, the impact of several key sensitivities were analysed, the results of which are demonstrated in Table 8-8.

Sensitivity	Variation	40-year pre-tax IRR
Generation and Supply CapEx		
Distribution CapEx		
Variable element of fuel input prices (electricity, gas, and waste heat)		
Variable element of energy sales tariffs for heat concurrent with variable element of fuel input prices (electricity, gas, and waste heat)		
Discount % against the counterfactual of the variable element of heat sales tariffs		
Heat demand usage change (loss of customers, gain of customers or building fabric efficiency savings)		
Effect of a significant reduction in availability of LZC or loss of waste heat source		
Heat network losses (primary/secondary)		

Table 8-8: Feltham HNDU sensitivities

In addition to those stated above, a project specific sensitivity was also undertaken in relation to connection to social housing loads. In the core analysis, social housing loads which were fed from an existing communal heating system were included in the network. The core analysis also included some loads which were fed from individual systems (e.g. gas combi boilers in each unit). For the network to connect to the latter would require communal conversion at a greater cost and at greater complexity than to an existing communal system. Communal conversion will require funding outside the scope of this project.

8.6 Summary

8.6.1 Key Risks

- The 3.8MVA supply required for the energy centre may not be possible until after 2035 due to grid constraints. It is possible that the cost of grid reinforcements may be higher than modelled and reduce the economic performance of the network.
- The yield from the aquifer bore hole may not achieve the required 105l/s and would need to be supplemented by another low carbon heat source or the network extent reduced.

See Appendix R for risk register.

8.6.2 Opportunities

- N/A

See Appendix R for HNDU opportunities matrix.

8.6.3 Customer

Feltham has very high heat demand, with the majority of loads densely gathered around the town centre. In addition, approximately 47% of the loads are council owned which reduces the risk of loss of customers.

8.6.4 Engineering Solution

The high-level hydrogeology study estimated that a ground borehole yield of less than 50% flowrate of the aspiration would be probable, albeit further investigation is required. A reduction in yield could be accommodated by reducing the network extent or by supplementing with another technology such as an air source heat pump. With the desire of LBH to decarbonise the borough, supplementing with ASHP would be the preferable option in order to meet decarbonisation targets.

This network is considered to be highly technically difficult largely due to the lack of a promising site to locate the Energy Centre to serve such a large heat demand and severe limitations of low carbon heat capacity but also requires some specialist crossings along the network route.

[48] Heat Cost Calculator (heattrust.org)
[49] Consumer price inflation, UK - Office for National Statistics
[50] Ofgem 2019 price cap data

8.6.5 Economic & Environmental

. This is a considerable carbon saving of 393 ktonnesCO2e over 40 years, which is equivalent to:

623,315

A round-trip economy ticket holder flying LHR -> JFK ->LHR (11,000km total) 623,315 times[51]

1.1% & 2.9%

1.1% of Hounslow's 40-year borough wide emissions and 2.9% of Hounslow's 40-year borough wide emissions from gas [52]

446,591

The carbon dioxide 446,591 mature tree's remove from the atmosphere in the same 40 years[53].

[51] International Civil Aviation Organisation ICAO Carbon Emissions Calculator
[52] London Borough of Hounslow Climate and Clean Air Annual Report 2021, 2019 data extrapolated over 40 years
[53] Tree Carbon Benefit -European Environment Agency

9. Brentford

9.1 Energy Demand & Mapping

9.1.1 Heat Demand

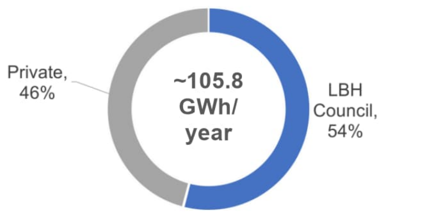

Figure 9-1: Brentford ownership of heat demand

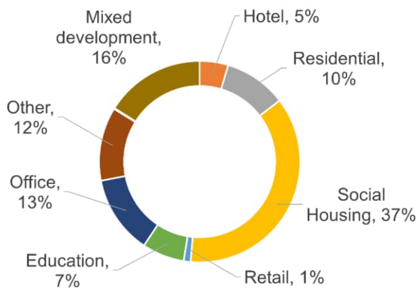

Figure 9-2: Brentford use type of heat demand

Undiversified (MW)	Diversified (MW)	Diversity
59.8	49.2	0.82

Table 9-1: Brentford network peak demand metrics

Note: see appendix C.3 for explanation of diversity.

ID	Load Name	Ownership	Annual Heat Demand (MWh)
373	Brentford Project Development	Private	8,060
476	Tesco Syon Lane Development	Private	8,043
411	GSK 980 Great West Road	Private	7,263
406	Green Dragon Lane Estate	Local Authority	6,903
465	Sky Campus (existing)	Private	5,467

Table 9-2: Brentford anchor loads

Figure 9-3 shows the 156 loads that have been identified in Brentford, with the size of the circle indicating the scale of their heat demand. 69 of these 156 loads have been included in the proposed district heat network with the others qualitatively omitted for the reasons indicated in the Figure Legend, which includes: unsuitability of the load to connect to district heating (e.g., no communal system), existing use of a low carbon heat source, request from LBH to exclude pre-planning site allocations (possible future developments) post-2025 and requirement to make specialist crossing of an obstruction, e.g., railway. Excluded loads can be found in Appendix D.

Brentford has extremely dense heat demand, 54% of the demand is from council owned loads. LBH has direct control over whether these buildings choose to connect to the network. The rest are private sector which carry the highest risk of not choosing to connect. Social Housing is the largest load type and is key to the realisation of this

There are significant loads that have been included that are dependent on crossing railways, rivers, and large roads. Access to these loads may not be possible or economic following assessment. There are several social housing estates that have been excluded from consideration as they are currently not supplied from a communal heat system and so require significant secondary side works to connect to district heating. These loads could undergo the required communal conversion of secondary systems and should be investigated in future; however, all in Brentford have been excluded from this initial analysis.

The methodology for energy demand analysis and mapping is set out in Appendix C.3 & C.4. In addition to heating loads demonstrated here, electrical & cooling loads have also been mapped and can be found in Appendix F. Due to the higher carbon savings provide by heat networks (replacing gas) compared to cooling networks (replacing electrically driven air-source heat pumps), the preferred network solution is heating only.

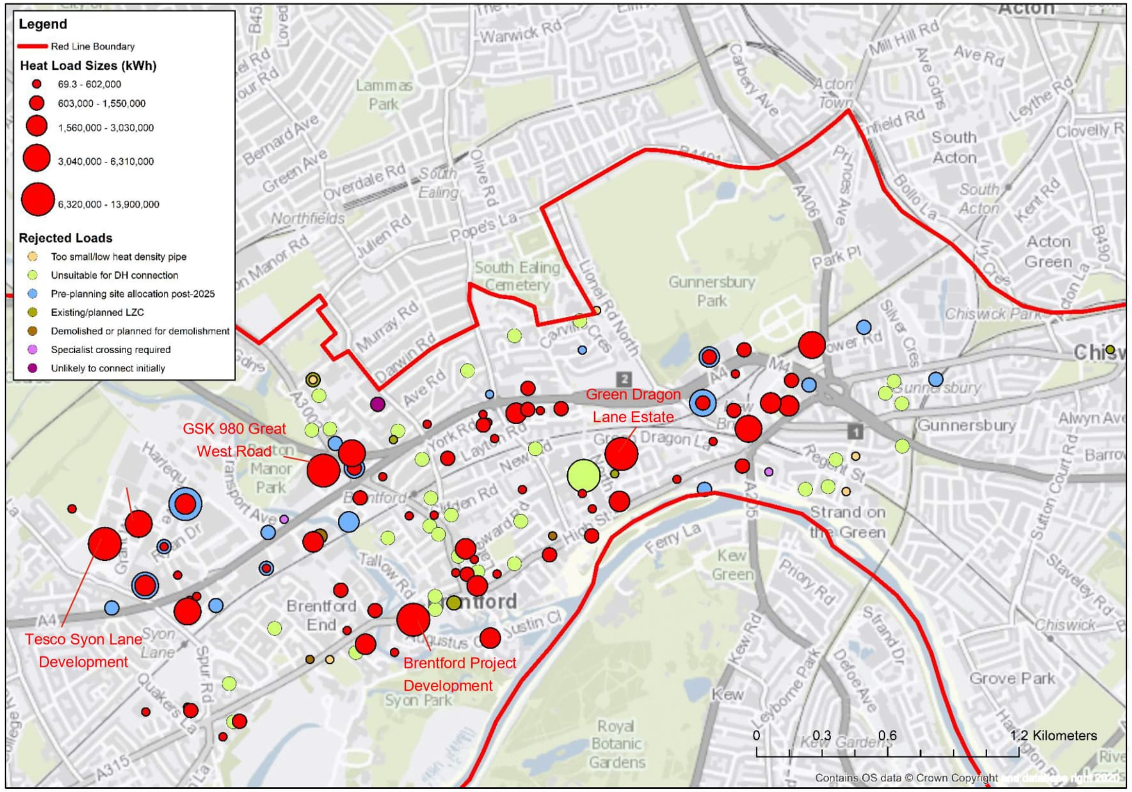

Figure 9-3: Brentford heat demand bubble map

9.2 Energy Centre Appraisals

To harness low and zero carbon heat (LZC), generate usable heat and deliver it via the network to connected buildings, Energy Centres (ECs) are required to host the necessary plant and equipment. The size of the ECs vary with capacity (power) of heat required to be delivered. This plant can be contained within suitable existing plantrooms or newly constructed, purpose-built buildings. To minimise infrastructure, it is preferred to locate ECs close to the preferred heat source and to the network customer buildings, however aspects such as land ownership and impact on residents and ecology are also considered.

Following the methodology set out in Appendix C.5.2, AECOM carried out an assessment to identify potential EC locations, and with LBH agreed the scoring criterion to qualitatively appraise these against each other. The complete appraisals can be found in Appendix G. An overview map with the key differentiating factors is shown in Figure 9-4 with factors coloured on a RAG scale according to their impact on the appraisal score. The highest scoring, and therefore, Preferred Option has been highlighted in green. This site was used in this initial technoeconomic modelling; however, all sites (and any others discovered in future) should be considered in future design stages.

There are many potential energy centre sites in Brentford, private, and council owned.

The scoring eliminated Gillette Studio, GSK, London Museum of Steam, Car Park Under Watermans and Ferry Quays Car Park, primarily due to the difficulty of delivering an EC at a private site and poor access to low and zero carbon heat sources.

Following surveys it was determined that Brentford Towers is an exceptionally good site. It houses an existing plant room that currently supplies the towers and historically also supplied the Haverfield Estate (together known as Green Dragon Lane Estate) and Green Dragon School. There is sufficient space in this plant room with potential for an extension (with reduced civils costs). However, a review of the low and zero carbon heat sources including hydrogeological potential around Brentford Towers rules out this option without long source to EC pipework which is likely not feasible.

A sufficient area of 1,100m² GIA has been located within the car park of Brent Lea Social Housing. This allows the building of a new standalone energy centre (see Appendix I for layout). The resultant loss of car parking spaces is to be approved by LBH. This site is in proximity to multiple low and zero carbon energy sources and is centrally located within the cluster.

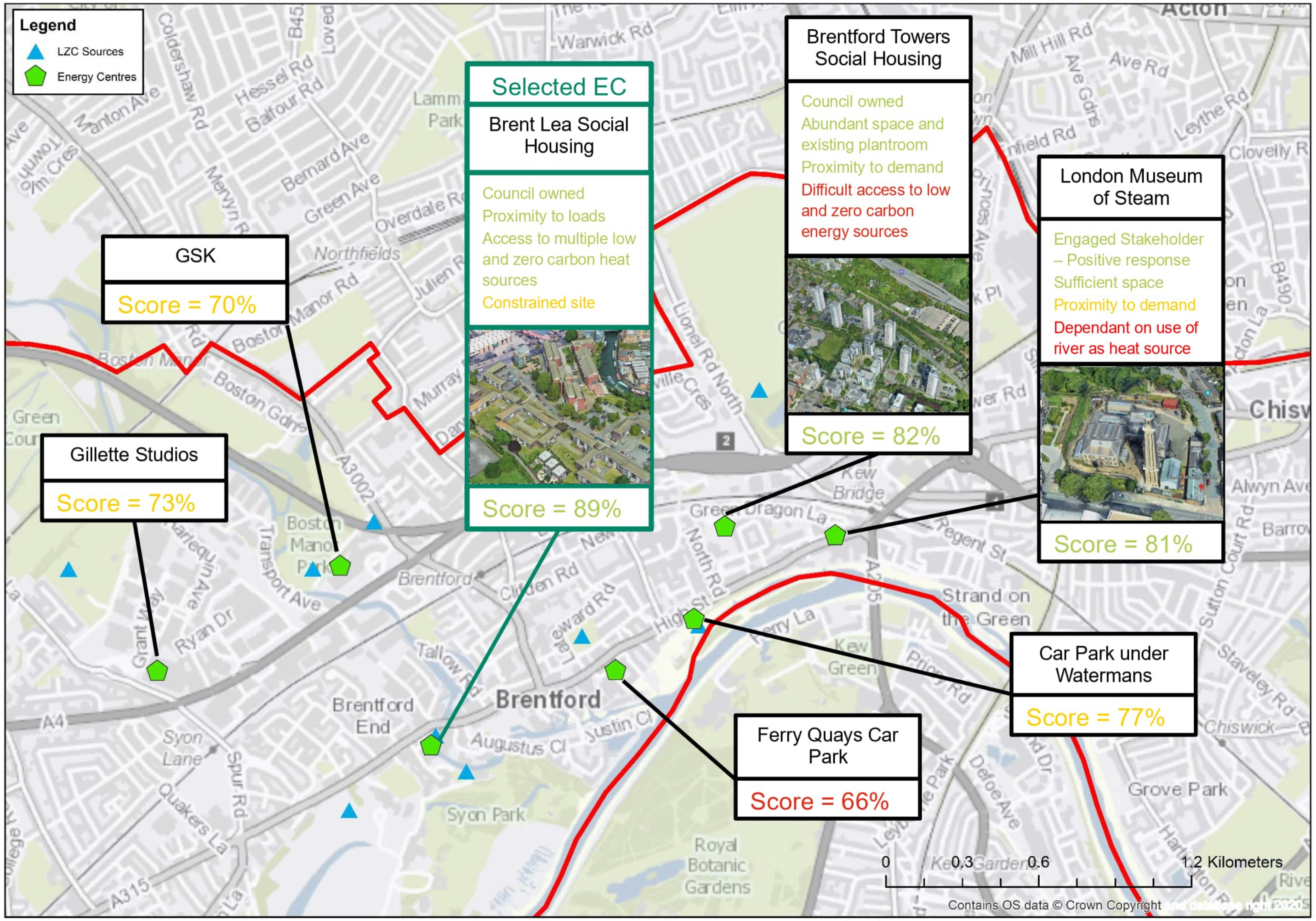

Figure 9-4: Brentford map of potential and selected energy centres

RAG: R=Red - a low or negative scoring criteria, A=Amber – a medium or neutral scoring parameter and G=Green – a high or positive scoring parameter

9.3 Low and Zero Carbon Heat Source Appraisals

To generate low and zero (LZC) carbon heat to supply the network, a source of ambient or waste heat is typically required. If this is 'low-grade' i.e., a lower temperature than is required by the network to serve the buildings it is connected to, then an electrically fuelled heat pump is required to boost this to a usable temperature.

Following the methodology set out in Appendix C.5.1, AECOM carried out an assessment to identify LZC source and with LBH agreed a scoring criterion to qualitatively appraise these against each other. The complete appraisals can be found in Appendix J. An overview map with the key differentiating factors is shown in Figure 9-5 with factors coloured on a RAG scale according to their impact on the appraisal score. The highest scoring, and therefore, Preferred Option has been highlighted in green. This source was used in this initial technoeconomic modelling; however, all sources (and any others discovered in future) should be considered in future design stages.

Waste heat recovery from the electrical transformer heat recovery scored poorly due to the likely inability to provide the scale and consistency of supply needed to meet demand. This source is heavily dependent on agreements with third parties as well as on third party utilisation of the asset (amount of electricity transmitted through the transformer) so are not well suited as the primary source.

Air-source heat pump is a good option however this would require significant, well-ventilated space to achieve the capacity needed. No large site without loss of green space was identified.

Water Source at the Brent or Thames Rivers is also a good option, however, may not achieve the required flow rates to meet demand (because of the tidal nature of these rivers) and is affected similarly to ASHP in winter.

All other options are open-loop ground source heat which is a mature technology and is a secure source of ambient heat, the efficiency of which is relatively unaffected by weather conditions. To construct the boreholes required for this technology typically requires a large area of open space, suitable for the use of a drilling rig. A review of hydrogeological potential showed southern sites (close to the river) had the best potential. The proximity to the preferred EC is a key consideration, which meant Syon Park was selected as the preferred location.

The available yield (heat capacity) from boreholes at can be difficult to estimate and is typically based on historical yields of those in proximity. The preliminary hydrogeological undertaken in this study estimated that less than 50% of the required yield could be obtained. In this initial technoeconomic modelling, it is assumed that the full required bore hole yield can be achieved. Following detailed hydrogeological studies and bore hole testing, if it is discovered that the required bole hole yield cannot be achieved, air source heat pumps are the preferred secondary option to uplift generation capacity to the required levels. See Appendix K for hydrogeological assessment.

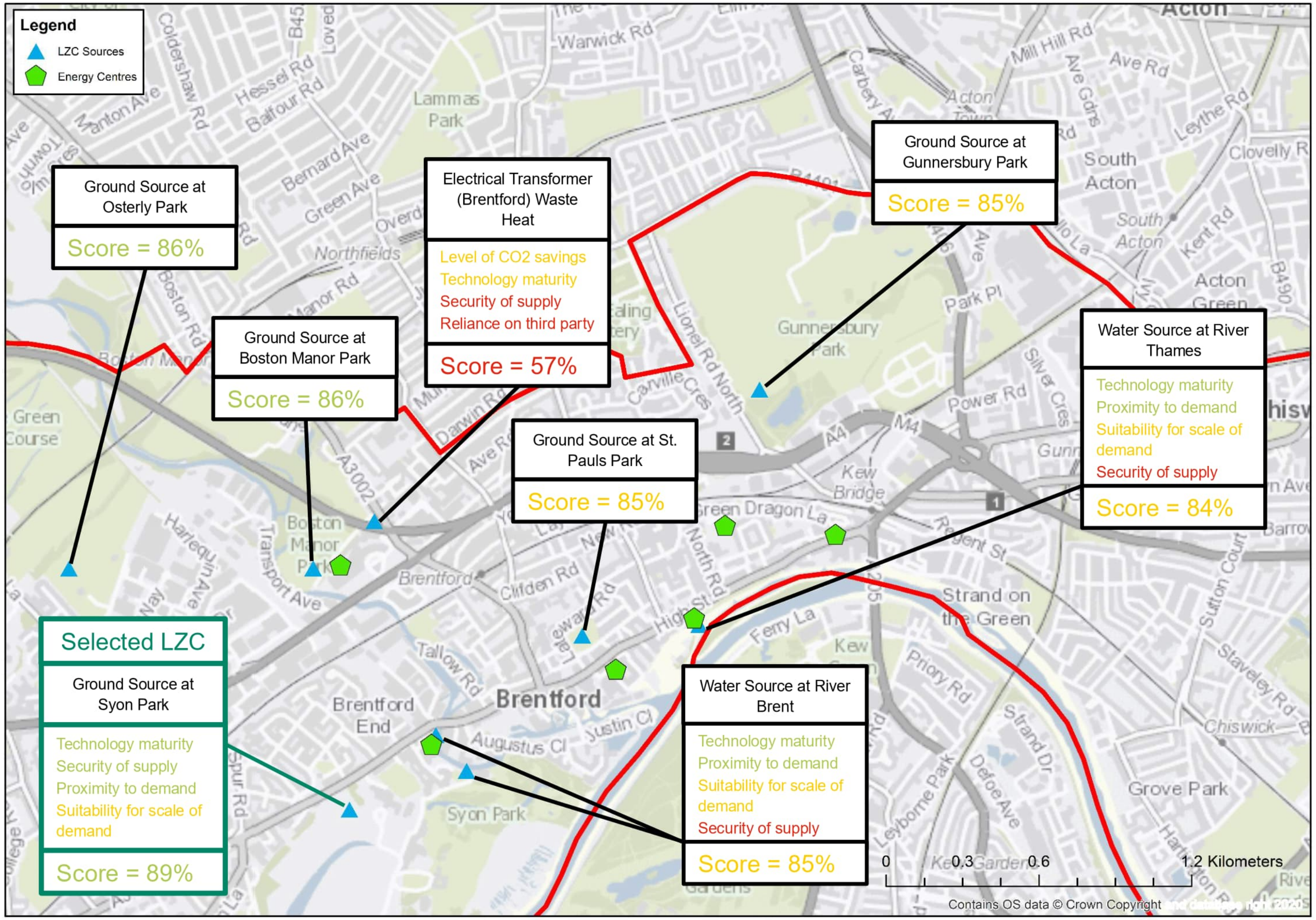

Figure 9-5: Brentford map of potential and selected LZC sources

9.4 Distribution System

This section details the initial proposed network to deliver heat from the energy centre to the customer buildings (loads). The pipe network shown in Figure 9-6 was designed in accordance with the methodology set out in Appendix C.6.

The network design was demand driven, in that the network has maximised the number of connectable loads to maximise the potential carbon savings from the project rather than being restricted by the available heat capacity, as noted in Section 9.3. In future design stages, the network extent can be refined to a "core" network that improves technical and economic performance at a smaller scale by including only anchor loads.

The key constraints are the River Thames, River Brent, Overground Railways, and the M4/A4 Chiswick Flyover. Crossing these obstructions is extremely costly and adds complexity. Since the many loads are separated by one or more of these constraints, the design decision has been made to cross all required constraints, however at later design stages each will undergo detailed costing to refine this decision.

Pipe routing is a multi-objective optimisation problem: minimise cost and minimise distance. Different cost rates (£/m) are assigned to each section of pipe to reflect the different dig types. A dig type is a description of the type of ground in which trenches are made to install the network pipework, with more dense urban environments being more expensive than open grassed area. These cost rates use in this initial technoeconomic analysis can be found in Appendix O.2, Table 15-36, and their application on the route shown in Figure 9-6.

Brentford is mainly urban dig type. Where possible back roads have been used to avoid traffic disruptions during construction. The A-315 has not been assigned extra-urban dig type in Brentford (unlike A-roads in other clusters) as part of this pipe could potentially be routed through watermans park which would be given a soft dig type at a lower cost, however this is not certain. As a conservative estimate the A-315 is specified as urban to reflect this potential cost saving.

13 specialist crossings have been specified including 1 river crossing, 5 railway crossings, and 7 crossings under the M4/A4 Chiswick Flyover.

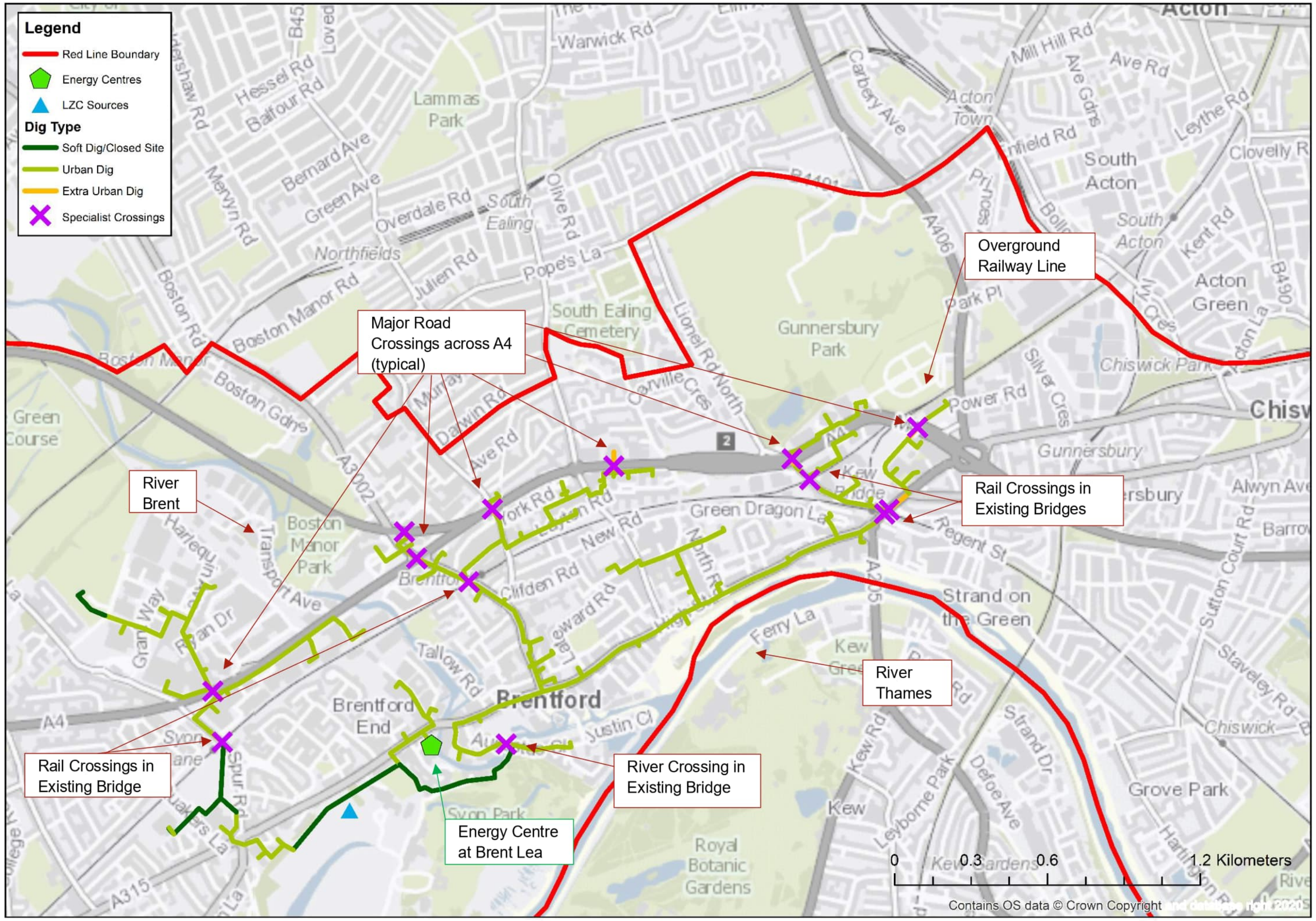

Figure 9-6: Brentford map of distribution system, dig types and constraints

Brentford is proposed as a heat-pump-led, third generation heating only network. A description of heat network technologies can be found in Appendix B.

A preliminary assessment of connected loads shows that ~74% currently require a ~80°C supply to provide the space heating comfort and domestic hot water requirements without fabric improvement and/or secondary side works. This is due to the age of the buildings and tendency for existing heating systems to operate on traditional 82°C/71°C temperature regimes which means these buildings are only suitable for connection to a high temperature third generation network. Connected buildings should be encouraged to undertake modifications to their buildings and systems to enable them to operate at lower temperatures without any compromise in comfort performance. If all connected buildings operated at a lower temperature the network supply temperature could be decreased becoming a fourth generation network with greater efficiency. Improved fabric should be the priority as this will also reduce consumption, but upgraded and rebalanced (optimised flow and return temperatures) heating systems should also be considered. The network has been modelled to include weather compensation to reduce operating temperatures during warmer weather when demand is lower, thereby reducing heat losses from the pipework. During winter the flow temperature is 80°C, which then reduces with increasing external air temperature, reaching a minimum of 70°C – require to generate domestic hot water in the 'worst case' connected loads. It is estimated that the network would operate at 70°C flow for over 90% the year, resulting in ~21% reduction in network losses and 16% increase in heat pump efficiency compared to a non-weather compensated network.

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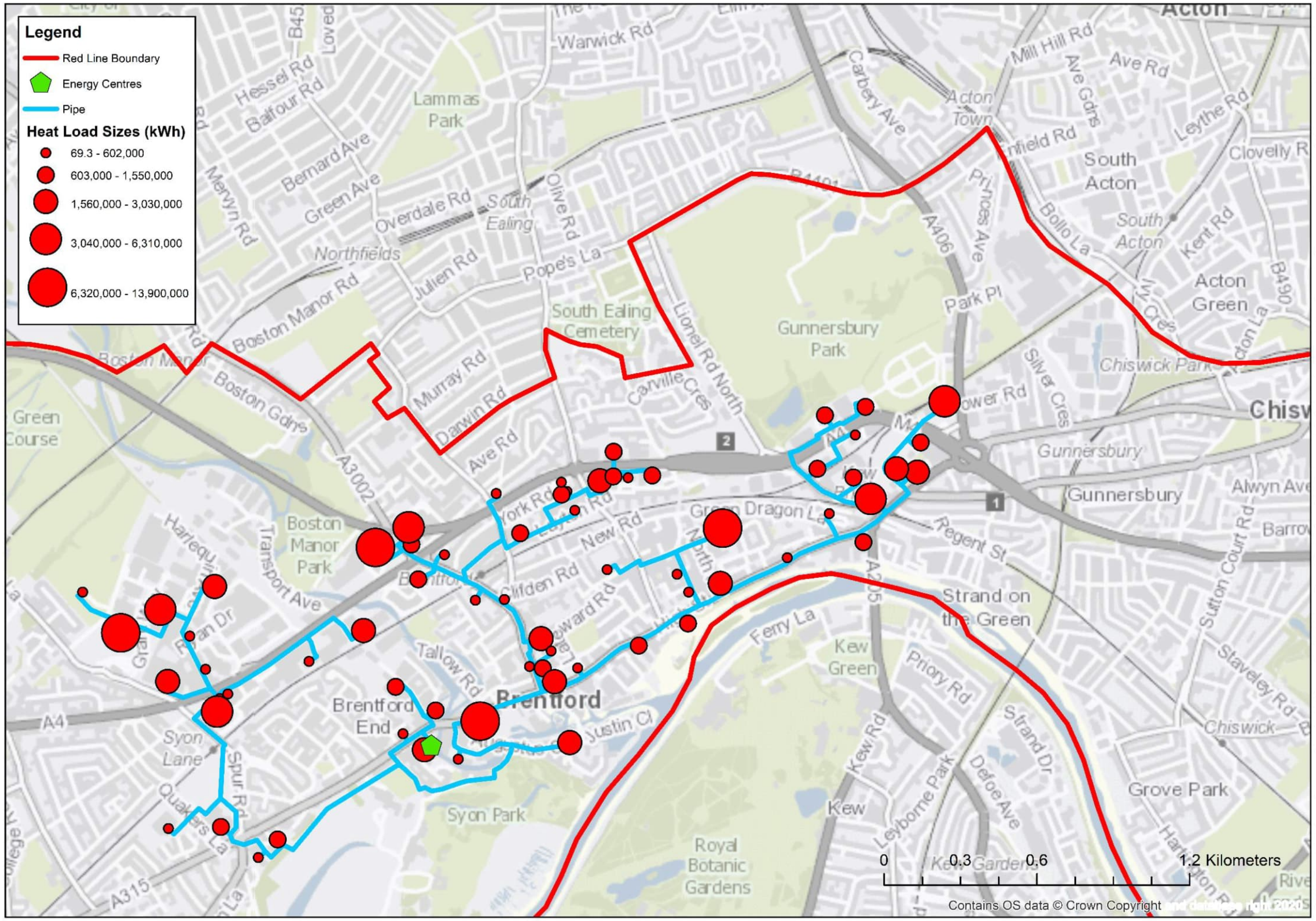


Figure 9-7: Brentford map of distribution system and connected loads

9.5 TEM Outputs

The above-described design for a district heating network has been analysed, to assess the performance of the solution against LBH environmental and economic aspirations. The methodology for techno-economic modelling is described in Appendix C.7 and the key modelling assumptions are detailed in Appendix O.

9.5.1 Generation Plant Specification

The generation plant detailed in Table 9-3 was determined through the initial technoeconomic modelling to achieve the target carbon intensity of heat of 100gCO2e/kWh (aligned with GHNF gated metrics and agreed with LBH) whilst satisfying the network demand with an economic plant composition and space efficient energy centre.

Attribute	Quantity
Energy Centre Internal Floor Area	1,100m²
Ground Source Heat Pump	2No. 1,875kW = 11,250kW
Heat Pump Refrigerant	Ammonia
Peaking and Resilient Gas Boiler	5No. 9,940kW = 49,700kW
Thermal Storage	560m³
Electrical Connection	6.2MVA

Table 9-3: Brentford generation plant specification

Initial design of the energy centre has been completed and is included in Appendix I. An application and budget request for a new electrical connection at the energy centre has been made to Scottish and Southern Electricity Network (SSEN), details of which can be found in Appendix L. The resultant budget quotes were formed without conducting grid analysis and therefore do not reflect potential grid reinforcement charges. The mitigate the risk of the cost in the formal quotation being higher than the budget figure, the cost of connection used in this initial technoeconomic analysis is based on previous projects rather than the quoted figures, however it is critical that these are reviewed in future design stages. The electrical grid is extremely constrained in West London, including Hounslow[54]. The GLA have warned significant new connection applications will not be approved until after 2035 once the grid can be reinforced. As such there is a risk that the 6.2MVA supply required for the energy centre may not be possible until that time.

9.5.2 Distribution System Specification

The key design metrics for the distribution system, as described in section 9.4 in demonstrated in Table 9-4 below:

Attribute	Quantity
Network Length	15,009m
Linear Heat Density	7,333 kWh/m
Flow/Return Temperatures	70-80°C / 40-50°C
Thermal Losses	[redacted]

Table 9-4: Brentford distribution system specification

9.5.3 Environmental Performance

Table 9-5 demonstrates the environmental performance of the network solution in respective to carbon savings.

Parameter	Quantity
40-year Cumulative Carbon Savings vs Gas Boilers (tCO_2e)	630 ktCO2e
40-year Cumulative Carbon Savings vs Gas Boilers (%)	69.7%
Year 1 Carbon Intensity of Heat (gCO_2e/kWh)	99 gCO2e/kWh

Table 9-5: Brentford environmental performance

9.5.4 Economic Results & Optimisation

The base case techno-economic modelling results include [redacted] domestic) and a heat tariff equal to the counterfactual cost (this is assessed for each load individually, however, the **average** non-domestic tariff is shown below in Table 5-6 and the **average** domestic tariff is shown below in Table 5-7 as an indicator). Optimisations are made to the parameters of three revenue sources to assess the requirements to achieve the target IRR of [redacted]

1. Grant Funding e.g., from the Green Heat Network Fund[55]
2. Increase in connection charge for non-domestic customers[56]
3. Increase in tariff for domestic customers

Fixed results (i.e., independent of the 3 revenue source variations detailed above) are shown in Table 9-6.

Parameter	Quantity
Heat Generation CapEx (£'mill)	[redacted]
Distribution CapEx (£'mill)	
Total CapEx[57] (£'mill)	
Annual OpEx (£)	
Avg. Non-domestic tariff (p/kWh)	
Counterfactual Levelised Cost of Heat[58] (p/kWh)	

Table 9-6: Brentford fixed economic results

	Optimisation Scenario	Base case	Max grant	Grant Goal Seek to Target IRR
Optimisations	Grant funding (% of CapEx)	[redacted]		
	Non-domestic connection fee (£/kW)			
	Avg. Domestic tariff (p/kWh)			
Results	IRR 40-year (%)			
	Levelised Cost of Heat (p/kWh)			
	Social IRR 40-year (%)			

Table 9-7: Brentford optimisation results

Note: Optimisations have been highlighted red where the value differs from the base case.

[54] London Housing Development Faces Delays to 2035 on Electricity Capacity - Bloomberg
[55] The upper limit of this was determined by applying GHNF guidance
[redacted]
[57] Including 15% risk, contractor preliminaries, contractor overhead and profit, and design

[58] Counterfactual Levelised Cost of Heat across all domestic and non-domestic with GHNF aligned mixture of gas boiler and ASHP counterfactuals, respectfully. Value levelised using a discount rate of 3.5%. This value is NOT equal to the heat tariff. The heat tariff is equal to the non-levelised counterfactual cost for a single load assessed for each load individually. Counterfactual LCoH is used as comparison to the scheme LCoH only.

9.5.4.1 Domestic Tariff Impact

9.5.4.2 Sensitivity Analysis

In line with HNDU requirements, the impact of several key sensitivities were analysed, the results of which are demonstrated in Table 9-8.

Sensitivity	Variation	40-year pre-tax IRR
Generation and Supply CapEx		
Distribution CapEx		
Variable element of fuel input prices (electricity, gas, and waste heat)		
Variable element of energy sales tariffs for heat concurrent with variable element of fuel input prices (electricity, gas, and waste heat)		
Discount % against the counterfactual of the variable element of heat sales tariffs		
Heat demand usage change (loss of customers, gain of customers or building fabric efficiency savings)		
Effect of a significant reduction in availability of LZC or loss of waste heat source		
Heat network losses (primary/secondary)		

Table 9-8: Brentford HNDU sensitivities

9.6 Summary

9.6.1 Key Risks

- The 6.2 MVA supply required for the energy centre may not be possible until after 2035 due to grid constraints. It is possible that the cost of grid reinforcements may be higher than modelled and reduce the economic performance of the network.
- The yield from the aquifer bore hole may not achieve the required 169l/s and would need to be supplemented by another low carbon heat source or the network extent reduced.
- Potential loss of load or additional cost and programme implications due to 13No. specialist crossings.

See Appendix R for risk register.

9.6.2 Opportunities

- N/A

See Appendix R for HNDU opportunities matrix.

9.6.3 Customer

Brentford has the highest heat demand, with the majority of loads densely gathered around the town centre. In addition, the majority (54%) of demand is from council owned loads which reduces the risk of loss of customers.

9.6.4 Engineering Solution

The high-level hydrogeology study estimated that a ground borehole yield of less than 50% flowrate of the aspiration would be probable, albeit further investigation is required. A reduction in yield could be accommodated by reducing the network extent or by supplementing with another technology such as an air source heat pump. With the desire of LBH to decarbonise the borough, supplementing with ASHP would be the preferable option in order to meet decarbonisation targets.

The Energy Centre is proposed to be location adjacent to the River Brent, and therefore harnessing this to supplement the shortfall in borehole yield is highly feasible. In addition, the site is on council owned land and is also in close proximity to some potential supplementary locations, which appear to be used for industrial purposes, and could be procured to alleviate the space impact of the Energy Centre on the Brent Lea site.

The network is considered to be technically feasible, though the number of specialist crossings adds significant complexity.

[59] Heat Cost Calculator (heattrust.org)
[60] Consumer price inflation, UK - Office for National Statistics
[61] Ofgem 2019 price cap data

9.6.5 Economic & Environmental

This is a considerable carbon saving of 603 ktonnesCO2e over 40 years, which is equivalent to:

956,384

A round-trip economy ticket holder flying LHR -> JFK ->LHR (11,000km total) 956,384 times[62]

1.7% & 4.7%

1.7% of Hounslow's 40-year borough wide emissions and 4.7% of Hounslow's 40-year borough wide emissions from gas [63]

685,227

The carbon dioxide 685,227 mature tree's remove from the atmosphere in the same 40 years[64].

[62] International Civil Aviation Organisation ICAO Carbon Emissions Calculator
[63] London Borough of Hounslow Climate and Clean Air Annual Report 2021, 2019 data extrapolated over 40 years
[64] Tree Carbon Benefit -European Environment Agency

10. Isleworth

10.1 Energy Demand & Mapping

10.1.1 Heat Demand

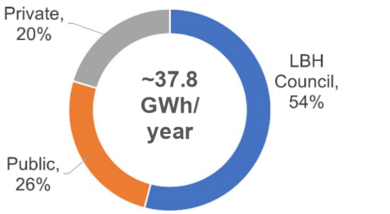


Figure 10-1: Isleworth ownership of heat demand

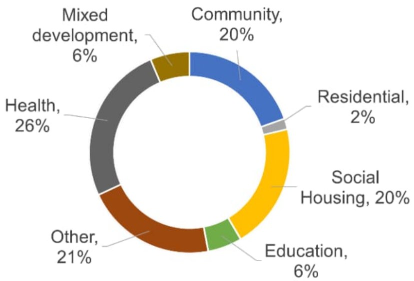


Figure 10-2: Isleworth Use Type of heat demand

Undiversified (MW)	Diversified (MW)	Diversity
15.7	13.5	0.86

Table 10-1: Isleworth network peak demand metrics

Note: see appendix C.3 for explanation of diversity.

ID	Load Name	Ownership	Annual Heat Demand (MWh)
541	West Middlesex University Hospital: Main Block	Public	8,416
510	Ivybridge Estate (communal)	Local Authority	7,243
540	West Middlesex University Hospital: East Wing	Public	4,304
552	Wynne Court	Local Authority	3,319
533	Twickenham Stadium	Private	2,176

Table 10-2: Isleworth anchor loads

Figure 10-3 shows the 51 loads that have been identified in Isleworth, with the size of the circle indicating the scale of their heat demand. 29 of these 51 loads have been included in the proposed district heat network with the others qualitatively omitted for the reasons indicated in the Figure Legend, which includes: unsuitability of the load to connect to district heating (e.g., no communal system), existing use of a low carbon heat source, request from LBH to exclude pre-planning site allocations (possible future developments) post-2025 and requirement to make specialist crossing of an obstruction, e.g., railway. Excluded loads can be found in Appendix D.

This cluster has relatively low-density heat demand, which is split into the Northern and Southern extremities. 54% of the demand is from council owned loads. LBH has direct control over whether these buildings choose to connect to the network. Public sector buildings (which account for 26% of demand) are next preferred due to the prevalent desire to achieve net-zero ambitions, followed by private sector which carry the highest risk of not choosing to connect. The planned introduction of Heat Network Zoning offers a potential means to reduce the risk of key loads choosing not to connect through its proposed mandating of specific sites to connect to a network within a zone where this is the lowest cost decarbonisation solution.

There are several social housing estates that have been excluded from consideration as they are currently not supplied from a communal heat system and so require significant secondary side works to connect to district heating. These loads could undergo the required communal conversion of secondary systems and should be investigated in future; however, most have been excluded from this initial analysis. 1No. communal conversion has been recommended, see Section 10.5.4.2 for sensitivity analysis of inclusion of this load.

The methodology for energy demand analysis and mapping is set out in Appendix C.3 & C.4. In addition to heating loads demonstrated here, electrical & cooling loads have also been mapped and can be found in Appendix F. Due to the higher carbon savings provide by heat networks (replacing gas) compared to cooling networks (replacing electrically driven air-source heat pumps), the preferred network solution is heating only.

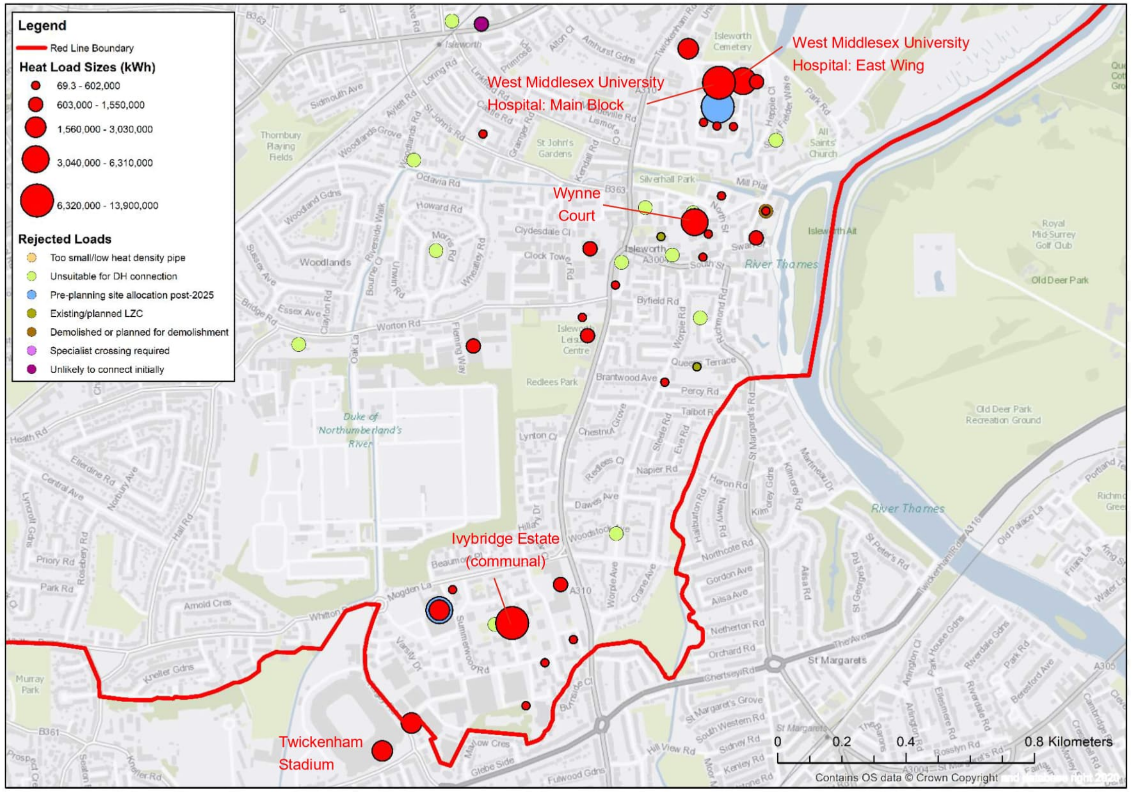


Figure 10-3: Isleworth heat demand bubble map

10.2 Energy Centre Appraisals

To harness low and zero carbon heat (LZC), generate usable heat and deliver it via the network to connected buildings, Energy Centres (ECs) are required to host the necessary plant and equipment. The size of the ECs vary with capacity (power) of heat required to be delivered. This plant can be contained within suitable existing plantrooms or newly constructed, purpose-built buildings. To minimise infrastructure, it is preferred to locate ECs close to the preferred heat source and to the network customer buildings, however aspects such as land ownership and impact on residents and ecology are also considered.

Following the methodology set out in Appendix C.5.2, AECOM carried out an assessment to identify potential EC locations, and with LBH agreed the scoring criterion to qualitatively appraise these against each other. The complete appraisals can be found in Appendix G. An overview map with the key differentiating factors is shown in Figure 10-4 with factors coloured on a RAG scale according to their impact on the appraisal score. The highest scoring, and therefore, Preferred Option has been highlighted in green. This site was used in this initial technoeconomic modelling; however, all sites (and any others discovered in future) should be considered in future design stages.

As with the appraisals in previous clusters, the results of scoring a mixture of private, public and council sites provides the answer that council owned sites are preferable when available and technically feasible. For this reason, the hospital and stadium have been ruled out.

On site at Mogden is commercially viable despite the private ownership, since positive engagement of Thames Water is necessary to access the selected low and zero carbon heat source (see section 10.3), however, space constraints mean this is not practical.

Following surveys, it was determined that Ivybridge Social Housing is an exceptionally good site. It houses an existing plant room that currently supplies the towers. There is sufficient space in this plant room with potential for an extension (with reduced civils costs).

A sufficient area of 640m² GIA has been located on the existing plant room site to build a new standalone energy centre (see Appendix I for layout).

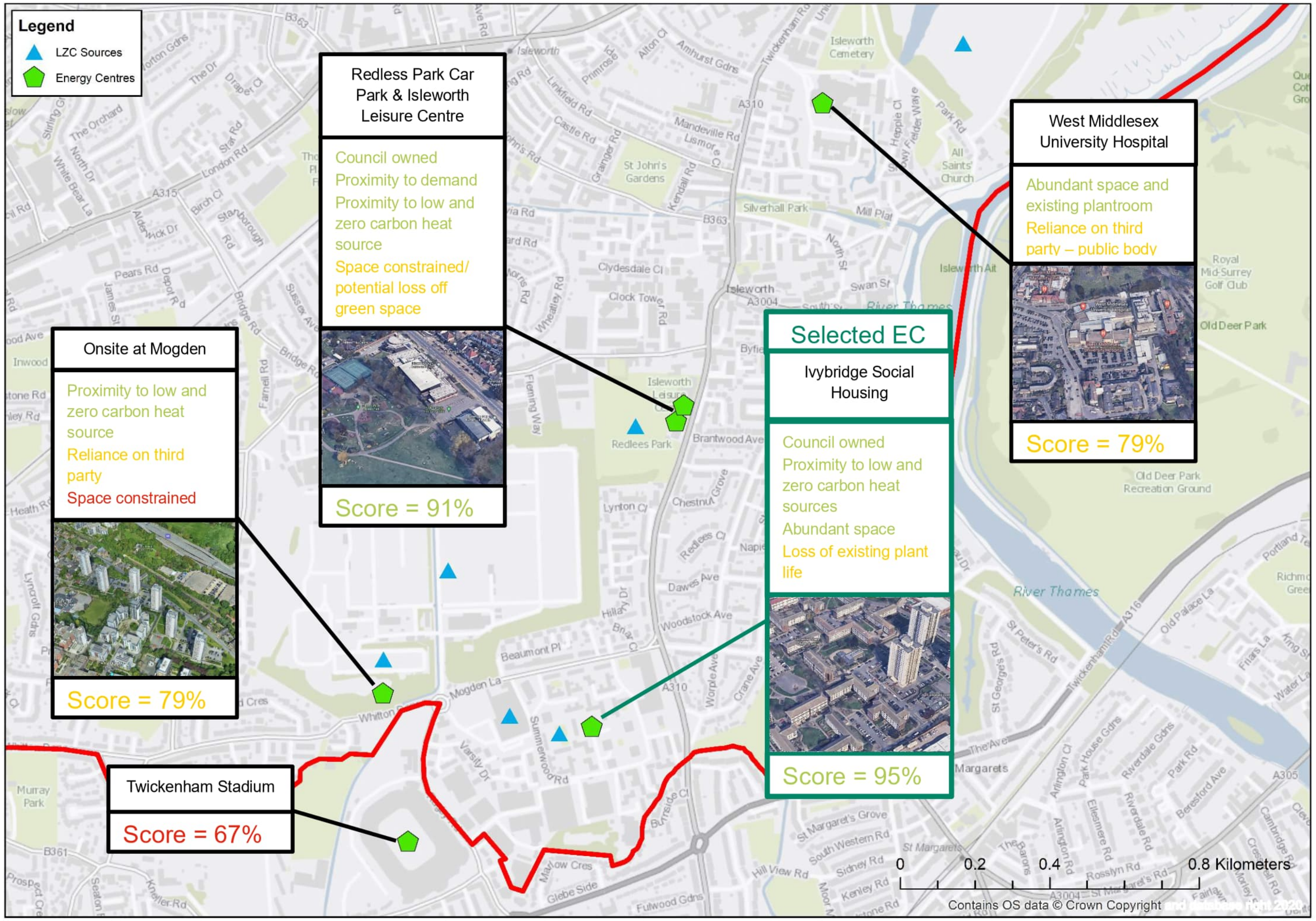


Figure 10-4: Isleworth map of potential and selected energy centres

RAG: R=Red - a low or negative scoring criteria, A=Amber – a medium or neutral scoring parameter and G=Green – a high or positive scoring parameter

10.3 Low and Zero Carbon Heat Source Appraisals

To generate low and zero (LZC) carbon heat to supply the network, a source of ambient or waste heat is typically required. If this is 'low-grade' i.e., a lower temperature than is required by the network to serve the buildings it is connected to, then an electrically fuelled heat pump is required to boost this to a usable temperature.

Following the methodology set out in Appendix C.5.1, AECOM carried out an assessment to identify LZC source and with LBH agreed a scoring criterion to qualitatively appraise these against each other. The complete appraisals can be found in Appendix J. An overview map with the key differentiating factors is shown in Figure 10-5 with factors coloured on a RAG scale according to their impact on the appraisal score. The highest scoring, and therefore, Preferred Option has been highlighted in green. This source was used in this initial technoeconomic modelling; however, all sources (and any others discovered in future) should be considered in future design stages.

Waste heat recovery from Tesco cooling scored poorly due to the likely inability to provide the scale and consistency of supply needed to meet demand. These sources are heavily dependent on agreements with third parties as well as on third party utilisation of the asset (use of cooling in the supermarket) so are not well suited as the primary source.

Biogas generated by anaerobic digestors using foul sewage at Mogden as process input can be burnt in a combined heat and power plant. Despite the gas being generated by "renewable" means the impact on local air quality and carbon emissions is greater than other options and so this option has been discounted. Should the energy centre require a decentralised power source, this option will be reconsidered.

Air-source heat pump is a good option however this would require significant, well-ventilated space to achieve the capacity needed. This technology is also inefficient during winter when demand is highest due to low air temperatures.

Open-loop ground source heat is a mature technology and is a secure source of ambient heat, the efficiency of which is relatively unaffected by weather conditions. To construct the boreholes required for this technology typically requires a large area of open space, suitable for the use of a drilling rig. The areas identified as the most promising are relatively close to each other and will likely provide similar flowrates. As such scored equally.

Waste heat from Mogden sewage provides the most secure and abundant low and zero carbon heat source. The supply is greater than could be utilised by the entirety of Hounslow. This option is dependent on buy in from the private owner Thames Water, however positive engagement has already begun, and it is likely that a commercial arrangement can be reached.

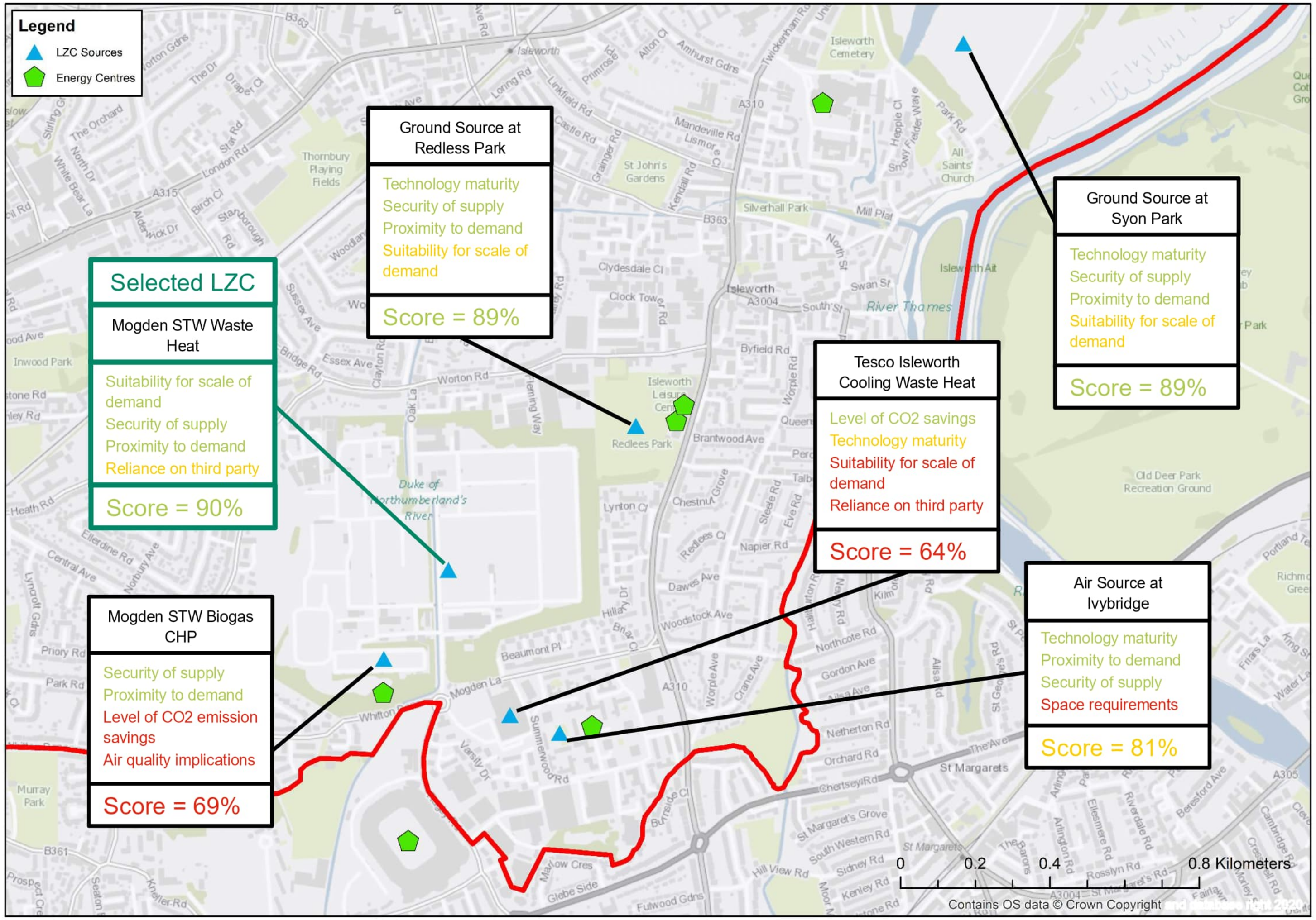


Figure 10-5: Isleworth map of potential and selected LZC sources

10.4 Distribution System

This section details the initial proposed network to deliver heat from the energy centre to the customer buildings (loads). The pipe network shown in Figure 10-6 was designed in accordance with the methodology set out in Appendix C.6.

The network design was demand driven, in that the network has maximised the number of connectable loads to maximise the potential carbon savings from the project rather than being restricted by the available heat capacity, as noted in Section 10.3. In future design stages, the network extent can be refined to a "core" network that improves technical and economic performance at a smaller scale by including only anchor loads.

The key constraints are the River Thames to the East and Mogden to the West. These constraints bound the accessible load in Isleworth.

Pipe routing is a multi-objective optimisation problem: minimise cost and minimise distance. Different cost rates (£/m) are assigned to each section of pipe to reflect the different dig types. A dig type is a description of the type of ground in which trenches are made to install the network pipework, with more dense urban environments being more expensive than open grassed area. These cost rates use in this initial technoeconomic analysis can be found in Appendix O.2, Table 15-36, and their application on the route shown in Figure 10-6.

Isleworth is mainly urban and extra-urban dig types, with the latter used along main A-roads. Where possible back roads have been used to avoid traffic disruptions during construction.

One specialist crossing has been (conservatively) specified in order to access load over the minor River Crane

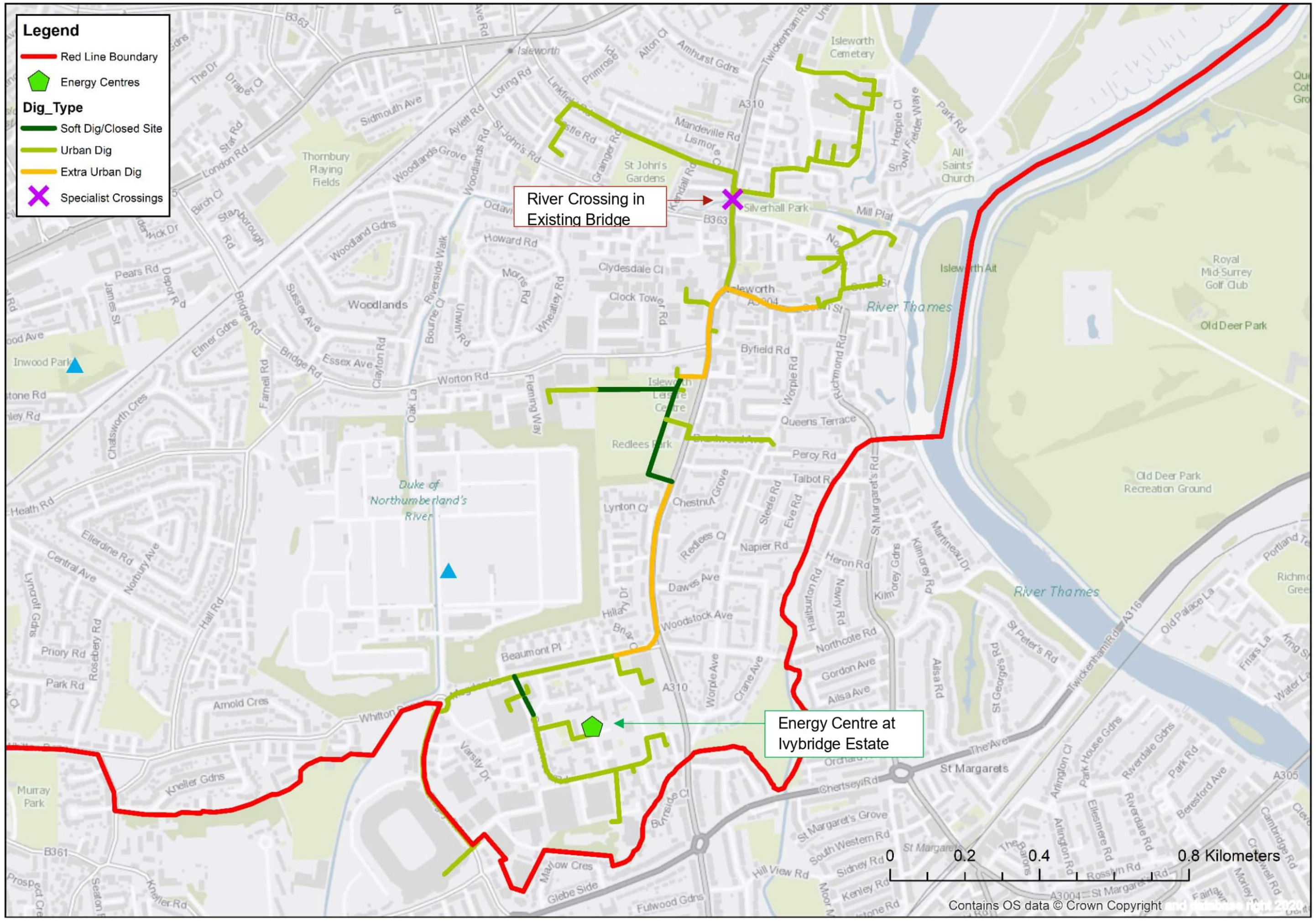


Figure 10-6: Isleworth map of distribution system, dig types and constraints

Isleworth is proposed as a heat-pump-led, third generation heating only network. A description of heat network technologies can be found in Appendix B.

A preliminary assessment of connected loads shows that ~89% currently require a ~80°C supply to provide the space heating comfort and domestic hot water requirements without fabric improvement and/or secondary side works. This is due to the age of the buildings and tendency for existing heating systems to operate on traditional 82°C/71°C temperature regimes which means these buildings are only suitable for connection to a high temperature third generation network. Connected buildings should be encouraged to undertake modifications to their buildings and systems to enable them to operate at lower temperatures without any compromise in comfort performance. If all connected buildings operated at a lower temperature the network supply temperature could be decreased becoming a fourth generation network with greater efficiency. Improved fabric should be the priority as this will also reduce consumption, but upgraded and rebalanced (optimised flow and return temperatures) heating systems should also be considered. The network has been modelled to include weather compensation to reduce operating temperatures during warmer weather when demand is lower, thereby reducing heat losses from the pipework. During winter the flow temperature is 80°C, which then reduces with increasing external air temperature, reaching a minimum of 70°C – require to generate domestic hot water in the 'worst case' connected loads. It is estimated that the network would operate at 70°C flow for over 90% the year, resulting in ~21% reduction in network losses and 16% increase in heat pump efficiency compared to a non-weather compensated network.

Steel pipework has been specified in lieu of PEX (plastic) to ensure the longevity of the infrastructure at the proposed operating temperatures and pressures.

In this initial technoeconomic modelling, the network construction commences in Q1 2027 in a single phase, achieving heat on to all loads in 2028. See high level project programme in Appendix Q. This programme will depend on the timeline for the subsequent design stages, the heat customer required connection dates and the availability of contractor resource to construct the network and their rate of install. It is possible that the preferred solution is found to be a phased installation of the network. These details are to be developed in future design stages, and upon completion of enhanced stakeholder engagement.

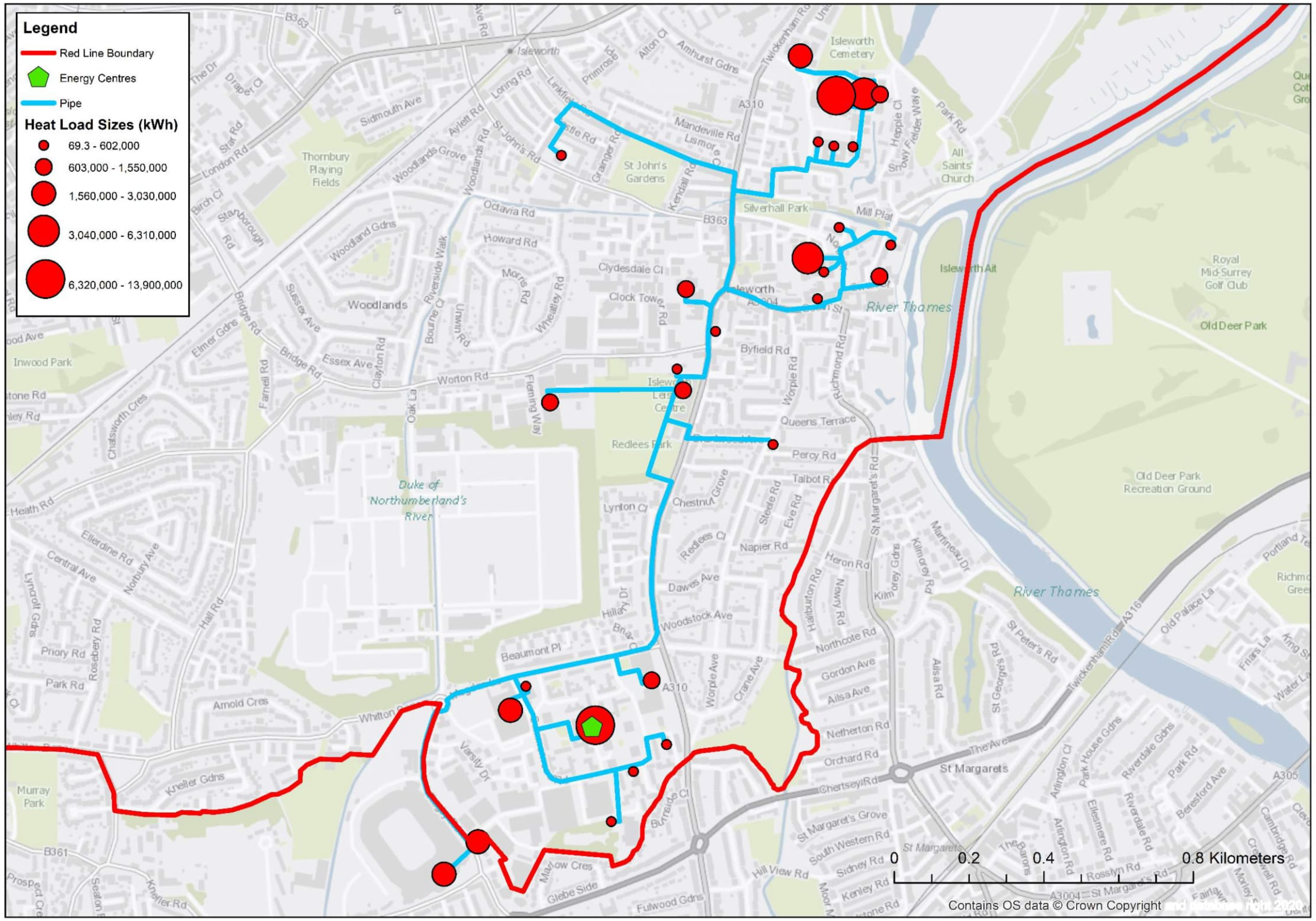


Figure 10-7: Isleworth map of distribution system and connected loads

10.5TEM Outputs

The above-described design for a district heating network has been analysed, to assess the performance of the solution against LBH environmental and economic aspirations. The methodology for techno-economic modelling is described in Appendix C.7 and the key modelling assumptions are detailed in Appendix O.

10.5.1 Generation Plant Specification

The generation plant detailed in Table 10-3 was determined through the initial technoeconomic modelling to achieve the target carbon intensity of heat of 100gCO2e/kWh (aligned with GHNF gated metrics and agreed with LBH) whilst satisfying the network demand with an economic plant composition and space efficient energy centre.

Attribute	Quantity
Energy Centre Internal Floor Area	640m²
Ground Source Heat Pump	2No. 1,750kW = 3,500kW
Heat Pump Refrigerant	Ammonia
Peaking and Resilient Gas Boiler	4No. 3,450kW = 13,800kW
Thermal Storage	180m³
Electrical Connection	1.9MVA

Table 10-3: Isleworth generation plant specification

Initial design of the energy centre has been completed and is included in Appendix I. An application and budget request for a new electrical connection at the energy centre has been made to Scottish and Southern Electricity Network (SSEN), details of which can be found in Appendix L. The resultant budget quotes were formed without conducting grid analysis and therefore do not reflect potential grid reinforcement charges. The mitigate the risk of the cost in the formal quotation being higher than the budget figure, the cost of connection used in this initial technoeconomic analysis is based on previous projects rather than the quoted figures, however it is critical that these are reviewed in future design stages. The electrical grid is extremely constrained in West London, including Hounslow[65]. The GLA have warned significant new connection applications will not be approved until after 2035 once the grid can be reinforced. As such there is a risk that the 1.9MVA supply required for the energy centre may not be possible until that time.

10.5.2 Distribution System Specification

The key design metrics for the distribution system, as described in section 10.4 in demonstrated in Table 10-4 below:

Attribute	Quantity
Network Length	7,676m
Linear Heat Density	5,169 kWh/m
Flow/Return Temperatures	70-80°C / 40-50°C
Thermal Losses	[redacted]

Table 10-4: Isleworth distribution system specification

10.5.3 Environmental Performance

Table 10-5 demonstrates the environmental performance of the network solution in respective to carbon savings.

Parameter	Quantity
40-year Cumulative Carbon Savings vs Gas Boilers (tCO_2e)	225 ktCO2e
40-year Cumulative Carbon Savings vs Gas Boilers (%)	70.0%
Year 1 Carbon Intensity of Heat (gCO_2e/kWh)	96 gCO2e/kWh

Table 10-5: Isleworth environmental performance

10.5.4 Economic Results & Optimisation

The base case techno-economic modelling results include no grant funding, a connecti[redacted] domestic) and a heat tariff equal to the counterfactual cost (this is assessed for each load individually, however, the **average** non-domestic tariff is shown below in Table 5-6 and the **average** domestic tariff is shown below in Table 5-7 as an indicator). Optimisations are made to the parameters of three revenue sources to assess the requirements to achieve the target IRR of [redacted]

1. Grant Funding e.g., from the Green Heat Network Fund[66]
2. Increase in connection charge for non-domestic customers[67]
3. Increase in tariff for domestic customers

Fixed results (i.e., independent of the 3 revenue source variations detailed above) are shown in Table 10-6.

Parameter	Quantity
Heat Generation CapEx (£'mill)	[redacted]
Distribution CapEx (£'mill)	
Total CapEx[68] (£'mill)	
Annual OpEx (£)	
Avg. Non-domestic tariff (p/kWh)	
Counterfactual Levelised Cost of Heat[69] (p/kWh)	

Table 10-6: Isleworth fixed economic results

	Optimisation Scenario	Base case	Max grant	Max grant + increased commercial connection	Max grant + increased commercial connection 2	Max Grant + increased domestic tariff
Optimisations	Grant funding (% of CapEx)	[redacted]				
	Non-domestic connection fee (£/kW)					
	Avg. Domestic tariff (p/kWh)					
Results	IRR 40-year (%)					
	Levelised Cost of Heat (p/kWh)					
	Social IRR 40-year (%)					

Table 10-7: Isleworth optimisation results

Note: Optimisations have been highlighted red where the value differs from the base case.

[65] London Housing Development Faces Delays to 2035 on Electricity Capacity - Bloomberg
[66] The upper limit of this was determined by applying GHNF guidance
[redacted]
Including 15% risk, contractor preliminaries, contractor overhead and profit, and design

[69] Counterfactual Levelised Cost of Heat across all domestic and non-domestic with GHNF aligned mixture of gas boiler and ASHP counterfactuals, respectfully. Value levelised using a discount rate of 3.5%. This value is NOT equal to the heat tariff. The heat tariff is equal to the non-levelised counterfactual cost for a single load assessed for each load individually. Counterfactual LCoH is used as comparison to the scheme LCoH only.

10.5.4.1 Domestic Tariff Impact

10.5.4.2 Sensitivity Analysis

In line with HNDU requirements, the impact of several key sensitivities were analysed, the results of which are demonstrated in Table 10-8.

Sensitivity	Variation	40-year pre-tax IRR
Generation and Supply CapEx		
Distribution CapEx		
Variable element of fuel input prices (electricity, gas, and waste heat)		
Variable element of energy sales tariffs for heat concurrent with variable element of fuel input prices (electricity, gas, and waste heat)		
Discount % against the counterfactual of the variable element of heat sales tariffs		
Heat demand usage change (loss of customers, gain of customers or building fabric efficiency savings)		
Effect of a significant reduction in availability of LZC or loss of waste heat source		
Heat network losses (primary/secondary)		

Table 10-8: Isleworth HNDU sensitivities

In addition to those stated above, a project specific sensitivity was also undertaken in relation to connection to social housing loads. In the core analysis, social housing loads which were fed from an existing communal heating system were included in the network. The core analysis also included some loads which were fed from individual systems (e.g. gas combi boilers in each unit). For the network to connect to the latter would require communal conversion at a greater cost and at greater complexity than to an existing communal system. Communal conversion will require funding outside the scope of this project.

10.6 Summary

10.6.1 Key Risks

- The 1.9MVA supply required for the energy centre may not be possible until after 2035 due to grid constraints. It is possible that the cost of grid reinforcements may be higher than modelled and reduce the economic performance of the network.
- Commercial agreement with Thames Water for purchase of waste cannot be reached.

See Appendix R for risk register.

10.6.2 Opportunities

- Isleworth could benefit from becoming the conduit between Mogden and the rest of the borough.

See Appendix R for HNDU opportunities matrix.

10.6.3 Customer

Isleworth contains areas of high heat demand; however, they are mostly located at the northern and southern extremities of the cluster, and single loads such as West Middlesex University Hospital and Twickenham Stadium or of high significance. The majority (54%) of demand is from council owned loads which reduces the risk of loss of customers.

10.6.4 Engineering Solution

The amount of waste heat available in Mogden is many magnitudes more than would be required to serve the Isleworth cluster and a high level of confidence can be held in the estimation of capacity as Thames Water have several years of metered data. The disparity is so great that Isleworth may not be able to benefit from the economy of scale of such a connection. Mogden also has biogas combined heat and power plant which could be used to provide low carbon heat and electricity to the network. This technology carries a security risk as Thames Water may decide in future to sell the biogas and discontinue power generation.

The Energy Centre is located on council owned property at Ivybridge and as proposed to be an extended version of the existing plantroom on site. This provides an opportunity to reuse existing equipment and reduce cost., however, the Energy Centre would be significantly larger than the existing plantroom and may receive negative responses from occupants due to the visual impact, and disturbance during construction. The network is considered to be technically feasible though the complexity of harnessing heat from Mogden is not justified for Isleworth alone.

[70] Heat Cost Calculator (heattrust.org)
[71] Consumer price inflation, UK - Office for National Statistics
[72] Ofgem 2019 price cap data

10.6.5 Economic & Environmental

This is a considerable carbon saving of 225 ktonnesCO2e over 40 years, which is equivalent to:

356,860

A round-trip economy ticket holder flying LHR -> JFK ->LHR (11,000km total) 356,860 times[73]

0.6% & 1.7%

0.6% of Hounslow's 40-year borough wide emissions and 1.7% of Hounslow's 40-year borough wide emissions from gas [74]

255,682

The carbon dioxide 255,682 mature tree's remove from the atmosphere in the same 40 years[75].

[73] International Civil Aviation Organisation ICAO Carbon Emissions Calculator
[74] London Borough of Hounslow Climate and Clean Air Annual Report 2021, 2019 data extrapolated over 40 years
[75] Tree Carbon Benefit -European Environment Agency

11. Borough Wide Network

11.1 Energy Demand & Mapping

11.1.1 Heat Demand

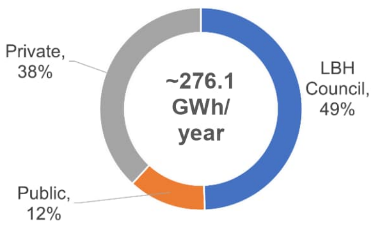


Figure 11-1: Borough Wide Network ownership of heat demand

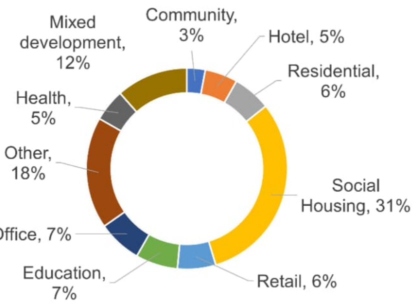


Figure 11-2: Borough Wide Network use type of heat demand

Undiversified (MW)	Diversified (MW)	Diversity
142.0	115.3	0.81

Table 11-1: Borough Wide Network – network peak demand metrics

Note: see appendix C.3 for explanation of diversity.

ID	Load Name	Ownership	Annual Heat Demand (MWh)
250	HMP/YOI Feltham	Public	13,453
541	West Middlesex University Hospital: Main Block	Public	8,416
373	Brentford Project Development	Private	8,060
476	Tesco Syon Lane Development	Private	8,043
411	GSK 980 Great West Road	Private	7,263

Table 11-2: Borough Wide Network anchor loads

Figure 11-3 shows the 506 loads that have been identified in Hounslow (excluding Cranford & Heston West), with the size of the circle indicating the scale of their heat demand. 247 of these 506 loads have been included in the proposed district heat network with the others qualitatively omitted for the reasons indicated in the Figure Legend, which includes: unsuitability of the load to connect to district heating (e.g., no communal system), existing use of a low carbon heat source, request from LBH to exclude pre-planning site allocations (possible future developments) post-2025 and requirement to make specialist crossing of an obstruction, e.g., railway. Excluded loads can be found in Appendix D.

The Borough Wide Network comprises 5 of the 6 clusters described in previous pages and as such is subject to the same demand. Brentford is the highest demand area with Feltham shortly behind. 49% of the demand is from council owned loads. LBH has direct control over whether these buildings choose to connect to the network. Public sector buildings are next preferred due to the prevalent desire to achieve net-zero ambitions, followed by private sector which carry the highest risk of not choosing to connect. Social Housing is the largest load type and is key to the realisation of this network. The largest load, HMP/YOI Feltham, accounts for ~5%. The loss of any one load is therefore less impactful on a network of this scale, although any loss of potential load is to be avoided. The planned introduction of Heat Network Zoning offers a potential means to reduce the risk of key loads choosing not to connect through its proposed mandating of specific sites to connect to a network within a zone where this is the lowest cost decarbonisation solution.

There are several social housing estates that have been excluded from consideration as they are currently not supplied from a communal heat system and so require significant secondary side works to connect to district heating. These loads could undergo the required communal conversion of secondary systems and should be investigated in future; however, most have been excluded from this initial analysis. 4No. communal conversion has been recommended, see Section 11.5.4.2 for sensitivity analysis of inclusion of these loads.

The methodology for energy demand analysis and mapping is set out in Appendix C.3 & C.4. In addition to heating loads demonstrated here, electrical & cooling loads have also been mapped and can be found in Appendix F. Due to the higher carbon savings provide by heat networks (replacing gas) compared to cooling networks (replacing electrically driven air-source heat pumps), the preferred network solution is heating only.

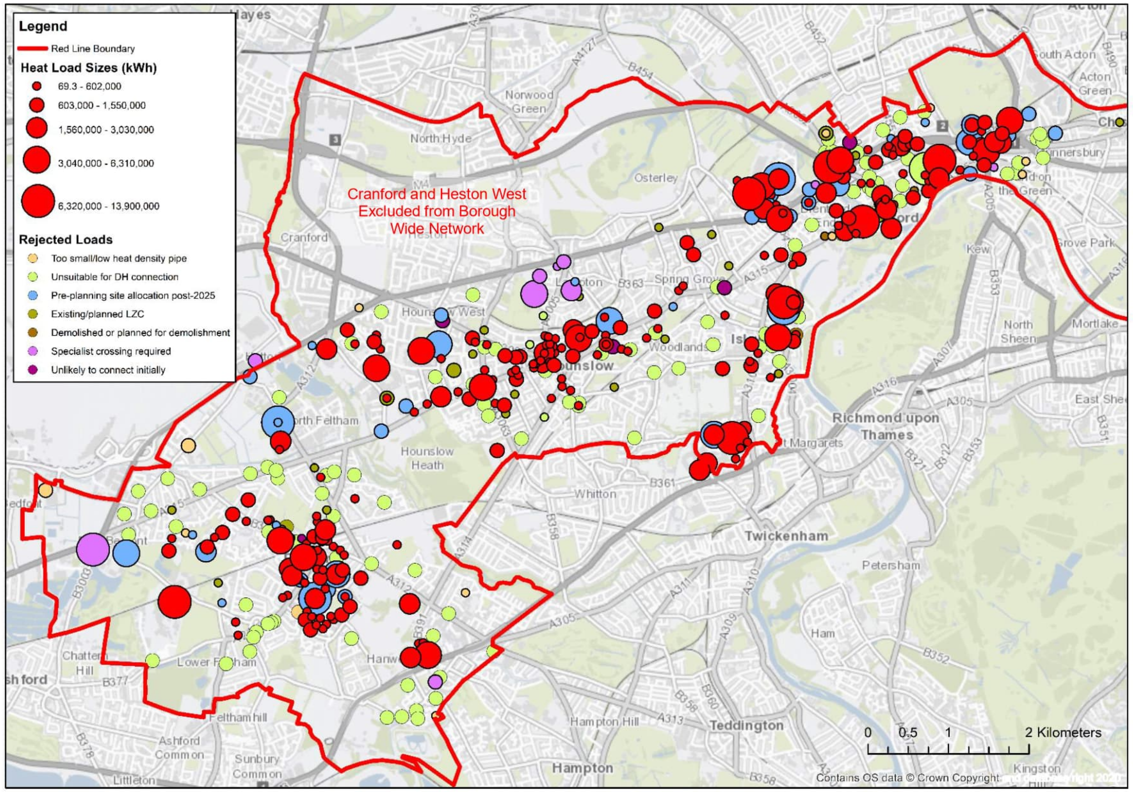


Figure 11-3: Borough Wide Network heat demand bubble map

11.2 Energy Centre Appraisals

To harness low and zero carbon heat (LZC), generate usable heat and deliver it via the network to connected buildings, Energy Centres (ECs) are required to host the necessary plant and equipment. The size of the ECs vary with capacity (power) of heat required to be delivered. This plant can be contained within suitable existing plantrooms or newly constructed, purpose-built buildings. To minimise infrastructure, it is preferred to locate ECs close to the preferred heat source and to the network customer buildings, however aspects such as land ownership and impact on residents and ecology are also considered.

Following the methodology set out in Appendix C.5.2, AECOM carried out an assessment to identify potential EC locations, and with LBH agreed the scoring criterion to qualitatively appraise these against each other. The complete appraisals can be found in Appendix G. An overview map with the key differentiating factors is shown in Figure 11-4 with factors coloured on a RAG scale according to their impact on the appraisal score. The highest scoring, and therefore, Preferred Option has been highlighted in green. This site was used in this initial technoeconomic modelling; however, all sites (and any others discovered in future) should be considered in future design stages.

Given the only low and zero carbon energy source large enough to supply the Borough Wide Network is located at Mogden in Isleworth (see section 11.3) it is only practical to select an energy centre from this cluster.

As per Isleworth standalone cluster energy appraisals (see section 10.2) the preferred energy centre location is Ivybridge social housing existing plantroom.

A sufficient area of 1,872m² GIA has been located at and adjacent to the existing Ivybridge plant room, to build a new standalone energy centre (see Appendix I for layout).

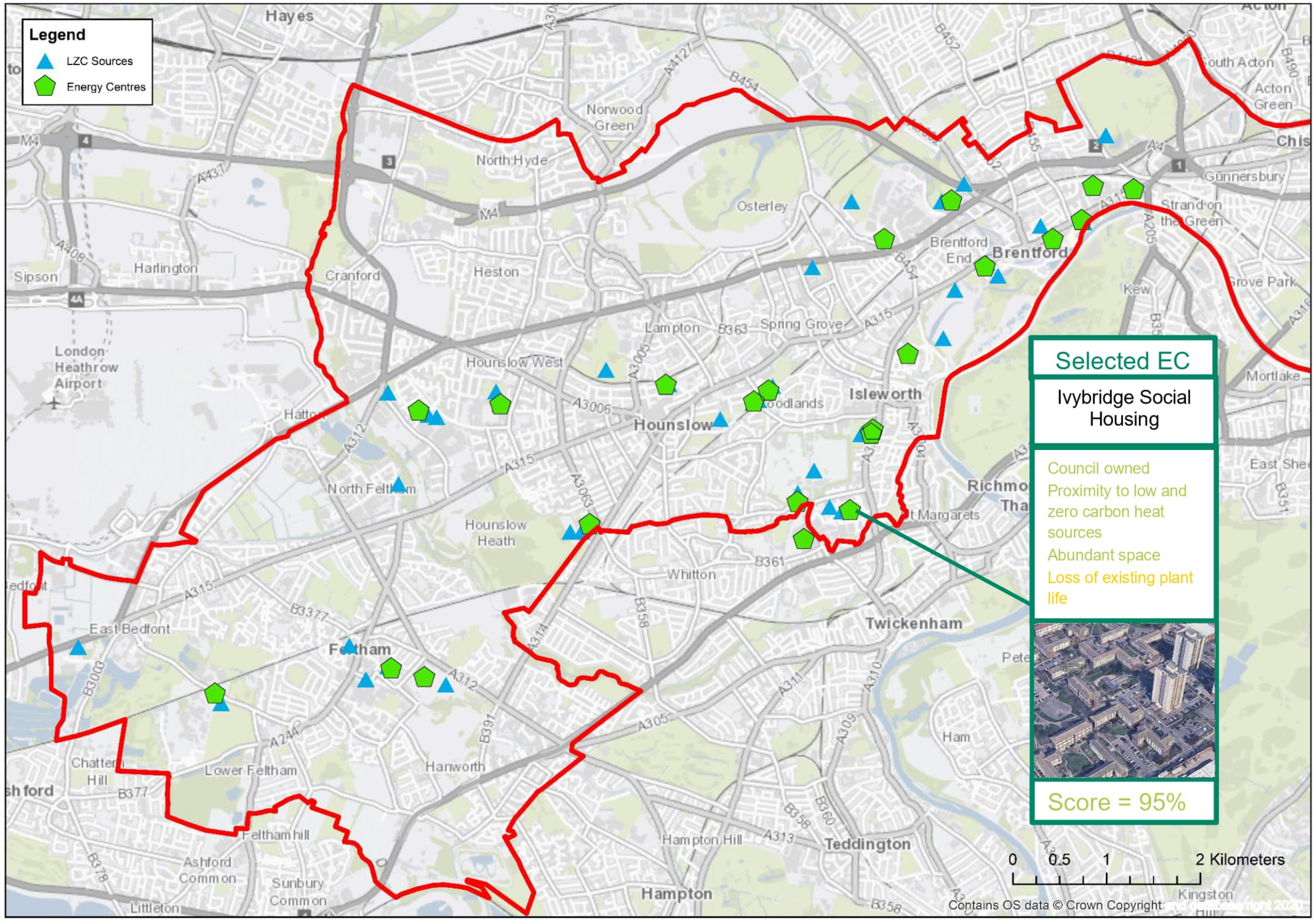


Figure 11-4: Borough Wide Network map of potential and selected energy centres

RAG: R=Red - a low or negative scoring criteria, A=Amber – a medium or neutral scoring parameter and G=Green – a high or positive scoring parameter

11.3 Low and Zero Carbon Heat Source Appraisals

To generate low and zero (LZC) carbon heat to supply the network, a source of ambient or waste heat is typically required. If this is 'low-grade' i.e., a lower temperature than is required by the network to serve the buildings it is connected to, then an electrically fuelled heat pump is required to boost this to a usable temperature.

Following the methodology set out in Appendix C.5.1, AECOM carried out an assessment to identify LZC source and with LBH agreed a scoring criterion to qualitatively appraise these against each other. The complete appraisals can be found in Appendix J. An overview map with the key differentiating factors is shown in Figure 11-5 with factors coloured on a RAG scale according to their impact on the appraisal score. The highest scoring, and therefore, Preferred Option has been highlighted in green. This source was used in this initial technoeconomic modelling; however, all sources (and any others discovered in future) should be considered in future design stages.

Given that the Borough Wide Network is comprised of 5 of the clusters described in this report. The potential low and zero carbon energy sources are the same as the sum of each cluster (excluding Cranford & Heston West).

It is possible that any combination of sources could be utilised to meet the required demand however this would likely require multiple (up to 5 energy centres) adding complexity and removing significant benefit of the Borough Wide Network.

Mogden Sewage Treatment Works which was selected as the preferred heat source for Isleworth, has enough waste heat to meet the demand of the entirety of Hounslow and Heathrow Airport (see section 12) with capacity to spare. It would be irresponsible to not take advantage of this enormous opportunity and so has been selected as the sole low and zero carbon heat source for the Borough Wide Network.

This simplifies delivery of the network by specifying a heat source (plus resiliency) and single energy centre.

To reiterate that said in section 10.3 This option is dependent on buy in from the private owner Thames Water, however positive engagement has already begun, and it is likely that a commercial arrangement can be reached.

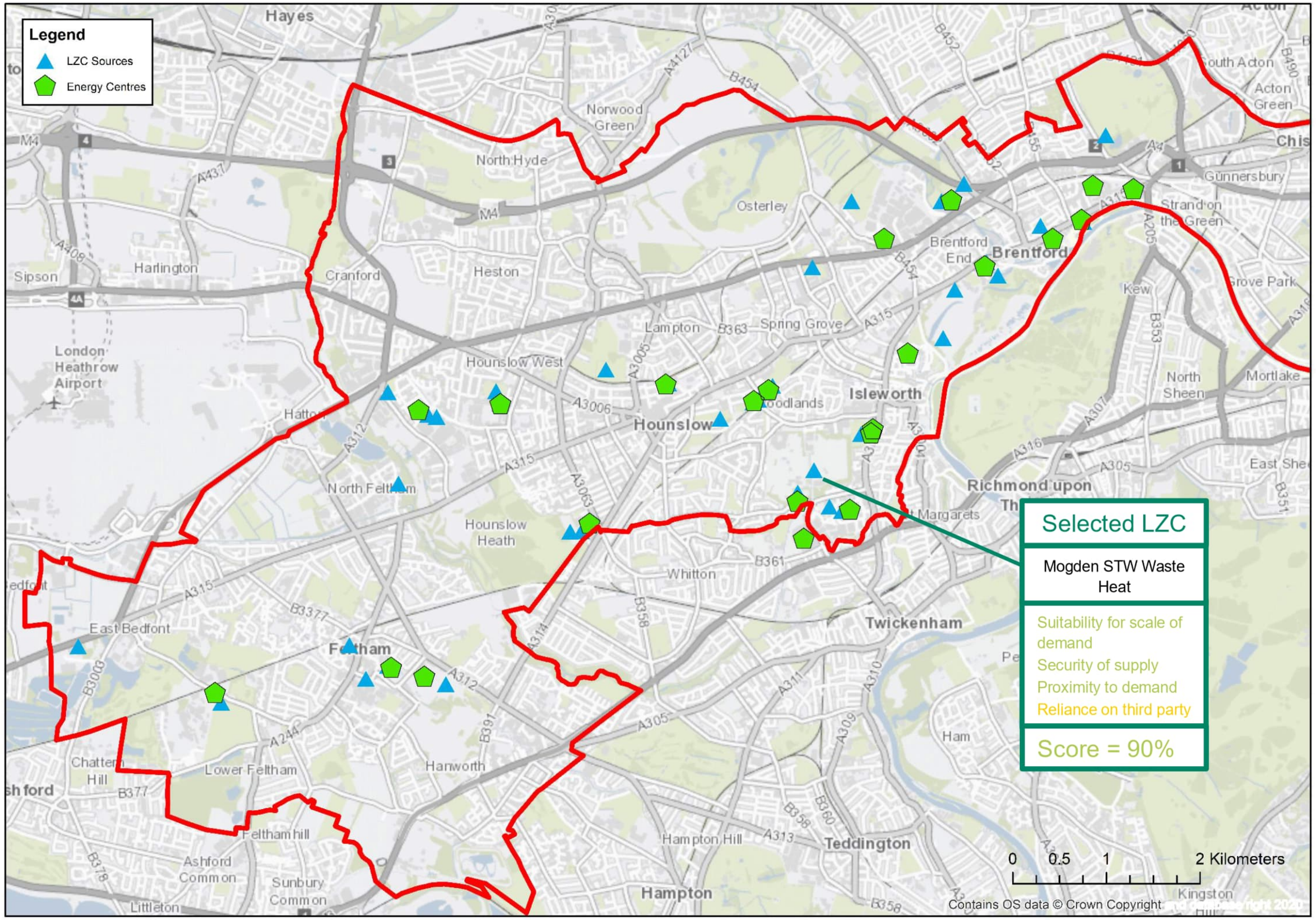


Figure 11-5: Borough Wide Network map of potential and selected LZC sources

11.4 Distribution System

This section details the initial proposed network to deliver heat from the energy centre to the customer buildings (loads). The pipe network shown in Figure 11-6 was designed in accordance with the methodology set out in Appendix C.6.

The network design was demand driven, in that the network has maximised the number of connectable loads to maximise the potential carbon savings from the project rather than being restricted by the available heat capacity, as noted in Section 11.3. In future design stages, the network extent can be refined to a "core" network that improves technical and economic performance at a smaller scale by including only anchor loads.

Since the Borough Wide Network comprises of 5 of the individual clusters the key constraints are the same as described in previous sections.

Pipe routing is a multi-objective optimisation problem: minimise cost and minimise distance. Different cost rates (£/m) are assigned to each section of pipe to reflect the different dig types. A dig type is a description of the type of ground in which trenches are made to install the network pipework, with more dense urban environments being more expensive than open grassed area. These cost rates use in this initial technoeconomic analysis can be found in Appendix O.2, Table 15-36, and their application on the route shown in Figure 11-6.

4 interconnections between the 5 clusters are required for the Borough Wide Network as shown in Figure 11-6. 1 additional specialist crossing is required at the Central and Hounslow West / Feltham Network Connection to cross a minor river.

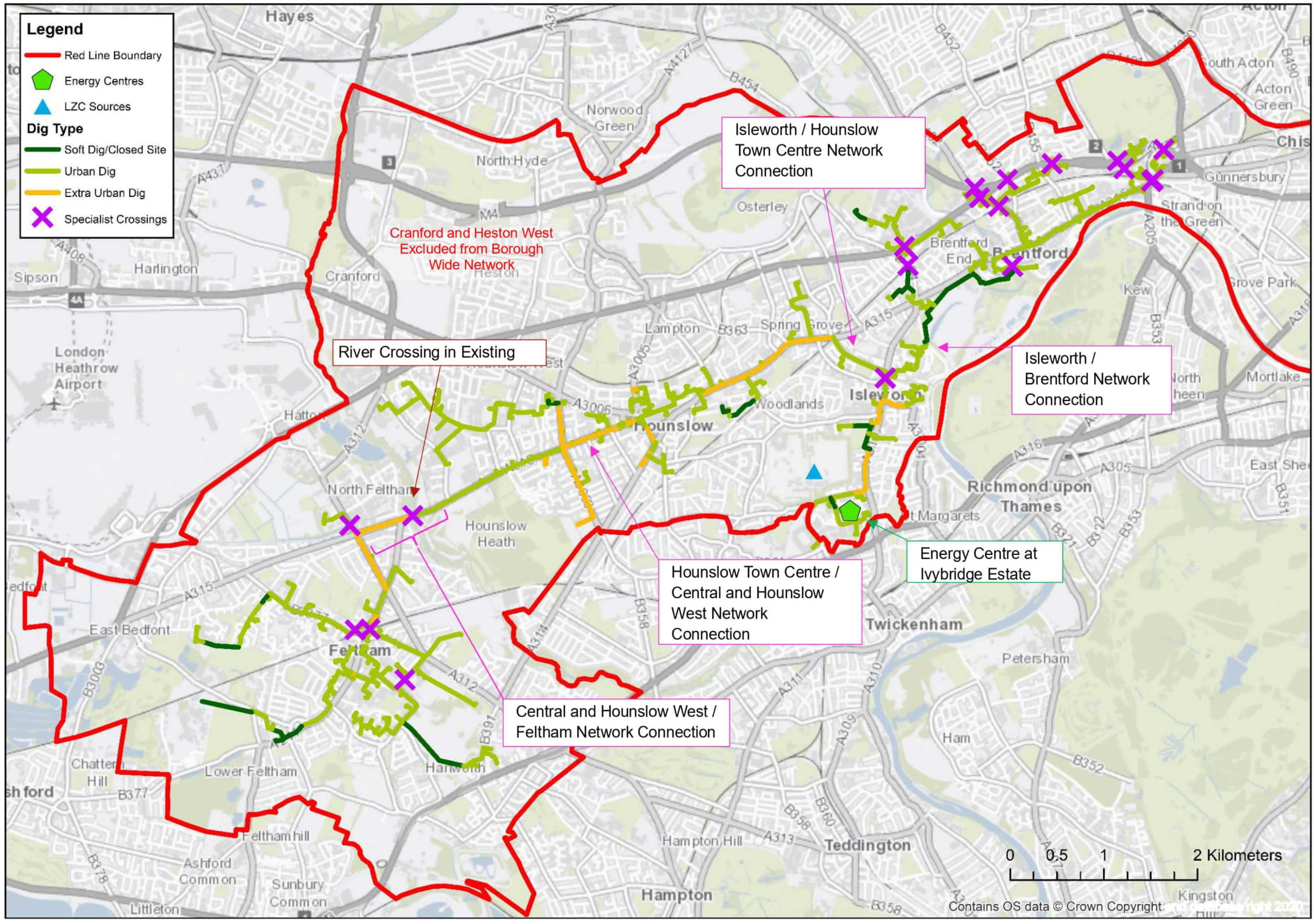


Figure 11-6: Borough Wide Network map of distribution system, dig types and constraints

The Borough Wide Network is proposed as a heat-pump-led, third generation heating only network. A description of heat network technologies can be found in Appendix B.

A preliminary assessment of connected loads shows that ~81% currently require a ~80°C supply to provide the space heating comfort and domestic hot water requirements without fabric improvement and/or secondary side works. This is due to the age of the buildings and tendency for existing heating systems to operate on traditional 82°C/71°C temperature regimes which means these buildings are only suitable for connection to a high temperature third generation network. Connected buildings should be encouraged to undertake modifications to their buildings and systems to enable them to operate at lower temperatures without any compromise in comfort performance. If all connected buildings operated at a lower temperature the network supply temperature could be decreased becoming a fourth generation network with greater efficiency. Improved fabric should be the priority as this will also reduce consumption, but upgraded and rebalanced (optimised flow and return temperatures) heating systems should also be considered. The network has been modelled to include weather compensation to reduce operating temperatures during warmer weather when demand is lower, thereby reducing heat losses from the pipework. During winter the flow temperature is 80°C, which then reduces with increasing external air temperature, reaching a minimum of 70°C – require to generate domestic hot water in the 'worst case' connected loads. It is estimated that the network would operate at 70°C flow for over 90% the year, resulting in ~21% reduction in network losses and 16% increase in heat pump efficiency compared to a non-weather compensated network.

Steel pipework has been specified in lieu of PEX (plastic) to ensure the longevity of the infrastructure at the proposed operating temperatures and pressures.

In this initial technoeconomic modelling, the network construction commences in Q1 2027 and has 3 phases as shown in Figure 11-7, achieving heat on to loads in 2028, 2029 and 2030. See high level project programme in Appendix Q. This programme will depend on the timeline for the subsequent design stages, the heat customer required connection dates and the availability of contractor resource to construct the network and their rate of install. These details are to be developed in future design stages, and upon completion of enhanced stakeholder engagement.

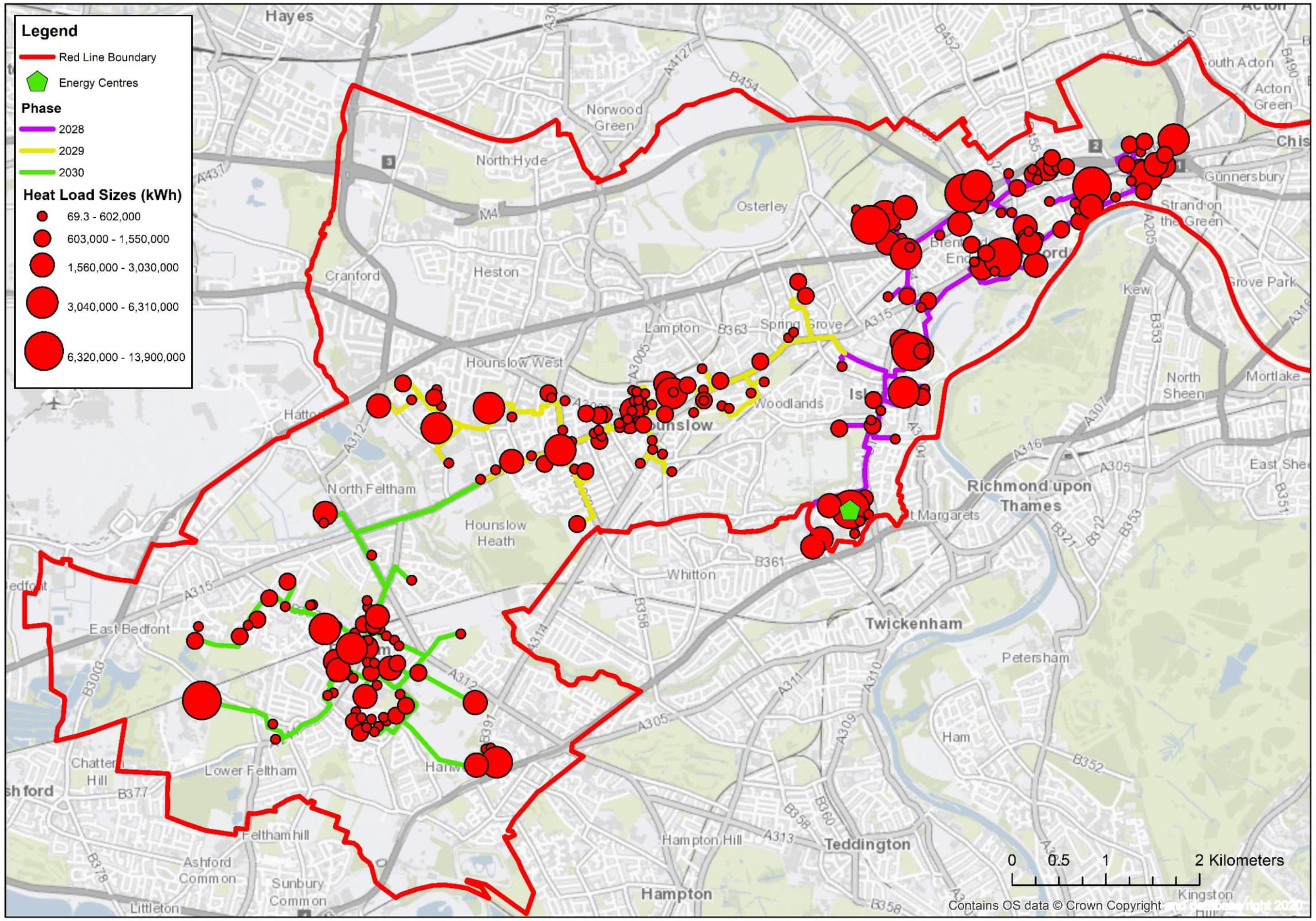


Figure 11-7: Borough Wide Network map of distribution system and connected loads

11.5TEM Outputs

The above-described design for a district heating network has been analysed, to assess the performance of the solution against LBH environmental and economic aspirations. The methodology for techno-economic modelling is described in Appendix C.7 and the key modelling assumptions are detailed in Appendix O.

11.5.1 Generation Plant Specification

The generation plant detailed in Table 11-3 was determined through the initial technoeconomic modelling to achieve the target carbon intensity of heat of 100gCO2e/kWh (aligned with GHNF gated metrics and agreed with LBH) whilst satisfying the network demand with an economic plant composition and space efficient energy centre.

Attribute	Quantity
Energy Centre Internal Floor Area	1,872m²
Ground Source Heat Pump	3No. 8,000kW = 24,000kW
Heat Pump Refrigerant	Ammonia
Peaking and Resilient Gas Boiler	12No. 9,775kW = 117,300kW
Thermal Storage	1,180m³
Electrical Connection	13.1MVA

Table 11-3: Borough Wide Network generation plant specification

Initial design of the energy centre has been completed and is included in Appendix I. An application and budget request for a new electrical connection at the energy centre has been made to Scottish and Southern Electricity Network (SSEN), details of which can be found in Appendix L. The resultant budget quotes were formed without conducting grid analysis and therefore do not reflect potential grid reinforcement charges. The mitigate the risk of the cost in the formal quotation being higher than the budget figure, the cost of connection used in this initial technoeconomic analysis is based on previous projects rather than the quoted figures, however it is critical that these are reviewed in future design stages. The electrical grid is extremely constrained in West London, including Hounslow[76]. The GLA have warned significant new connection applications will not be approved until after 2035 once the grid can be reinforced. As such there is a risk that the 13.1MVA supply required for the energy centre may not be possible until that time.

11.5.2 Distribution System Specification

The key design metrics for the distribution system, as described in section 11.4 in demonstrated in Table 11-3 below:

Attribute	Quantity
Network Length	59,746m
Linear Heat Density	4,803 kWh/m
Flow/Return Temperatures	70-80°C / 40-50°C
Thermal Losses	[redacted]

Table 11-4: Borough Wide Network distribution system specification

11.5.3 Environmental Performance

Table 11-5 demonstrates the environmental performance of the network solution in respective to carbon savings.

Parameter	Quantity
40-year Cumulative Carbon Savings vs Gas Boilers (tCO_2e)	1,435 ktCO2e
40-year Cumulative Carbon Savings vs Gas Boilers (%)	63.4%
Year 1 Carbon Intensity of Heat (gCO_2e/kWh)	65 gCO2e/kWh
Peak (Year 3) Carbon Intensity of Heat (gCO_2e/kWh)	100 gCO2e/kWh

Table 11-5: Borough Wide Network environmental performance

11.5.4 Economic Results & Optimisation

The base case techno-economic modelling results include no grant funding, a conn [redacted] domestic) and a heat tariff equal to the counterfactual cost (this is assessed for each load individually, however, the **average** non-domestic tariff is shown below in Table 5-6 and the **average** domestic tariff is shown below in Table 5-7 as an indicator). Optimisations are made to the parameters of three revenue sources to assess the requirements to achieve the target IRR of [redacted]

1. Grant Funding e.g., from the Green Heat Network Fund[77]
2. Increase in connection charge for non-domestic customers[78]
3. Increase in tariff for domestic customers

Fixed results (i.e., independent of the 3 revenue source variations detailed above) are shown in Table 11-6.

Parameter	Quantity
Heat Generation CapEx (£'mill)	[redacted]
Distribution CapEx (£'mill)	
Total CapEx[79] (£'mill)	
Annual OpEx (£'mill)	
Avg. Non-domestic tariff (p/kWh)	
Counterfactual Levelised Cost of Heat[80] (p/kWh)	

Table 11-6. Borough Wide Network fixed economic resul

	Optimisation Scenario	Base case	Max grant	Grant Goal Seek to Target IRR
Optimisations	Grant funding (% of CapEx)	[redacted]		
	Non-domestic connection fee (£/kW)			
	Avg. Domestic tariff (p/kWh)			
Results	IRR 40-year (%)			
	Levelised Cost of Heat (p/kWh)			
	Social IRR 40-year (%)			

Table 11-7: Borough Wide Network optimisation results

Note: Optimisations have been highlighted red where the value differs from the base case.

[76] London Housing Development Faces Delays to 2035 on Electricity Capacity - Bloomberg
[77] The upper limit of this was determined by applying GHNF guidance.
[redacted]
[79] Including 15% risk, contractor preliminaries, contractor overhead and profit, and design

[80] Counterfactual Levelised Cost of Heat across all domestic and non-domestic with GHNF aligned mixture of gas boiler and ASHP counterfactuals, respectfully. Value levelised using a discount rate of 3.5%. This value is NOT equal to the heat tariff. The heat tariff is equal to the non-levelised counterfactual cost for a single load assessed for each load individually. Counterfactual LCoH is used as comparison to the scheme LCoH only.

11.5.4.1 Domestic Tariff Impact

11.5.4.2 Sensitivity Analysis

In line with HNDU requirements, the impact of several key sensitivities were analysed, the results of which are demonstrated in Table 11-8.

Sensitivity	Variation	40-year pre-tax IRR
Generation and Supply CapEx		
Distribution CapEx		
Variable element of fuel input prices (electricity, gas, and waste heat)		
Variable element of energy sales tariffs for heat concurrent with variable element of fuel input prices (electricity, gas, and waste heat)		
Discount % against the counterfactual of the variable element of heat sales tariffs		
Heat demand usage change (loss of customers, gain of customers or building fabric efficiency savings)		
Effect of a significant reduction in availability of LZC or loss of waste heat source		
Heat network losses (primary/secondary)		

Table 11-8: Borough Wide Network HNDU sensitivities

In addition to those stated above, a project specific sensitivity was also undertaken in relation to connection to social housing loads. In the core analysis, social housing loads which were fed from an existing communal heating system were included in the network. The core analysis also included some loads which were fed from individual systems (e.g. gas combi boilers in each unit). For the network to connect to the latter would require communal conversion at a greater cost and at greater complexity than to an existing communal system. Communal conversion will require funding outside the scope of this project.

11.6 Summary

11.6.1 Key Risks

- The 13.1 MVA supply required for the energy centre may not be possible until after 2035 due to grid constraints. It is possible that the cost of grid reinforcements may be higher than modelled and reduce the economic performance of the network.
- Commercial agreement with Thames Water for purchase of waste cannot be reached.

See Appendix R for risk register.

11.6.2 Opportunities

- Excess waste heat from Mogden and the extent of the network may enable Heathrow Airport to become a customer leading to increase of ~60% demand on the network. This is to be explored further in later design stages.

See Appendix R for HNDU opportunities matrix.

11.6.3 Customer

The Borough wide network has an extremely large heat demand, with over 49% from council owned loads which reduces the risk of loss of customers and provides a high level of confidence on security of demand on which a network could be initiated and developed until it reached a critical mass at which less secure customers, e.g., private sector, may be more willing to connect. At this point, with the existence of a network, new developments could be encouraged by the LBH planning stipulations to connect to the network.

11.6.4 Engineering Solution

The Engineering solution is the same as described for Isleworth in section 10.6.4 simply scaled up to the demand of the complete borough.

The network constraints to the Borough Wide network are not materially different from the sum of the cluster networks, as there is good connectivity between the 5 clusters.The network is considered to be technical feasible due to the high level of confidence in the capacity of low carbon heat capacity, promising energy centre locations, and security of demand in highly dense clusters, some of which, such as Feltham and Central and Hounslow West, have limited opportunity to generate sufficient heat for their demand.

[81] Heat Cost Calculator (heattrust.org)
[82] Consumer price inflation, UK - Office for National Statistics
[83] Ofgem 2019 price cap data

11.6.5 Economic & Environmental

[redacted]. This is a considerable carbon saving of 1,435 ktonnesCO2e over 40 years, which is equivalent to:

2,275,971

A round-trip economy ticket holder flying LHR -> JFK ->LHR (11,000km total) 2,275,971 times[84]

0.6% & 1.5%

0.6% of Hounslow's 40-year borough wide emissions and 1.5% of Hounslow's 40-year borough wide emissions from gas [85]

1,630,682

The carbon dioxide 1,630,682 mature tree's remove from the atmosphere in the same 40 years[86].

[redacted]

[84] International Civil Aviation Organisation ICAO Carbon Emissions Calculator
[85] London Borough of Hounslow Climate and Clean Air Annual Report 2021, 2019 data extrapolated over 40 years
[86] Tree Carbon Benefit -European Environment Agency
[87] This would be subject to negotiation between the network and Heathrow Airport

12. Heathrow Airport

In a meeting between LBH and Heathrow Airport on 07/04/22, it was noted that Heathrow typically consumes 170-180GWh/year of natural gas, estimated to be circa. 165GWh of heat demand[88]. If Heathrow were to add a third runway, it is estimated that the total demand for heating would be circa. 250GWh/year[89]. Provided space can be found for a suitably sized energy centre to harness and deliver it, there is more than enough[90] waste heat available in Mogden STW to provide low carbon heat to both the full Hounslow network and Heathrow Airport. By 2030, this heat would be 93% cleaner than natural gas, rising to 98% by 2040.

It is understood that Heathrow have a number of existing heat networks, however the largest is believed to be supplied from an Energy Centre in the south of the site, approximately 2 – 2.5 km from the closest section of the proposed Hounslow Borough Wide network. Connectivity therefore is deemed at this early stage to be technically feasible.

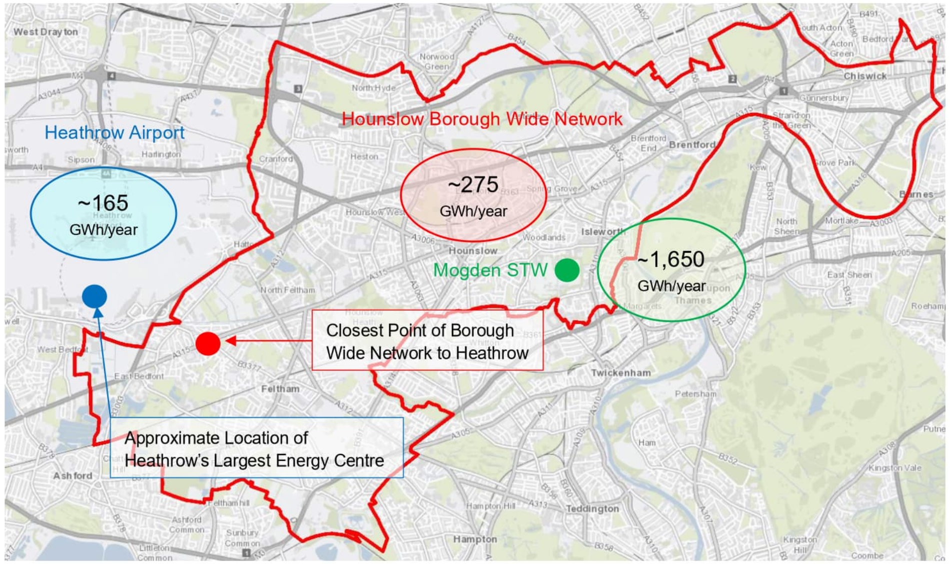


Table 12-1: Opportunity between Hounslow, Mogden STW, and Heathrow

[88] Natural gas boilers operate at an efficiency typically <90% but highly variable with age and temperature
[89] https://www.heathrow.com/content/dam/heathrow/web/common/documents/company/about/airports-commission/technical-assessment/10_Heathrow_3RNW_-_Resource_Efficiency.pdf

13. Zero Carbon Route Map

The district heating network(s) proposed in this report are only a steppingstone to net zero carbon. Several further steps are needed to maximise the value of the network and address all building related emissions. The first priority in developing a net zero strategy is to maximise opportunities for demand reduction and energy efficiency. This hierarchy, illustrated in the diagram below, is crucial for developing a cost effective, socially responsible, and robust carbon management plan.[91]. Please see Appendix S for route map.

Figure 13-1: Zero Carbon Route Map Schematic

14. Recommendation

Table 14-1 provides an overview of cluster results pre-economic refinement. Average domestic heat tariff and carbon intensity are coloured GREEN to indicate that the base case meets the project environmental and social objectives set out in Section 2.2. 40-year IRR is coloured RED to indicate that the base case does not meet the economic objective set out in Section 2.2 Following economic refinement to align the proposed networks to meet the economic objective, Table 14-2 provides an overview of cluster results post economic refinement including the measures For all

Cluster Network	Hounslow Town Centre	Central & Hounslow West	Cranford & Heston West	Feltham	Brentford	Isleworth	Borough Wide

Table 14-1: Overview Results – Pre-Economic Refinement (Base Case)

[91] Adapted from *'Figure 1: The Carbon Trust three stage approach to developing a robust carbon management strategy'* (2006).

Cluster Network	Hounslow Town Centre	Central & Hounslow West	Cranford & Heston West	Feltham	Brentford	Isleworth	Borough Wide
40-year IRR (%)							
Grant Funding (% of CapEx)							
Domestic Tariff Increase from Base Case (%)							
Resultant Avg. Domestic Tariff							

Table 14-2: Overview Results - Post Economic Refinement

In summary, the recommended network solutions to be taken forward to feasibility stage are:

1. Hounslow Borough Wide Network + Heathrow Airport Network
2. Brentford Standalone Network
3. Isleworth, Brentford, and Hounslow Town Centre Network

15. Next Steps

The recommended next steps are:

15.1 Governance

To progress this project from its current conceptual state to detailed feasibility and further heat network development and design stages, it is advisable for appropriate project-level governance to be put in place. Project governance in the context of heat network and infrastructure project development, ensures that the investing organisation – in this case likely to be London Borough of Hounslow for the near future as a minimum – has the appropriate mapping of personnel, authority, and accountability, to define, control, and steer the cross-cutting infrastructure project, ultimately leading the scheme to realise its benefits of carbon emissions reduction and financial returns.

This project governance approach will establish key roles throughout the Hounslow DHN project delivery lifecycle, identifying responsibilities and accountabilities within the core LBH team, in addition to their aligned internal stakeholders / departments, external stakeholders, and project advisors. The core governance roles/team will apply financial and technical control over the works, ensure decisions are made in an informed and effective way, and ensure sufficient capability and capacity is maintained in the LBH organisation. The governance framework should set out appropriate limits of authority, delegated responsibilities, and clearly define escalation routes within the project environment.

Effective governance provides:

- Control over project delivery – ensuring check and balances are in place e.g.
  - appropriate signoffs and assurances are received for each stage of the project lifecycle, before further stages are commenced,

  - project finances are understood, communicated, tracked, and reported upon,
  - project schedule is reported, appropriate, and cross-organisational integration is in place, and
  - decision points and gateways are monitored and controlled

- Confidence to the project sponsor and senior LBH leaders that adequate project control and reporting is in place, with sufficient information provided to them to inform necessary decisions, and
- Confidence to LBH's board of directors, executives, and political appointees, that the infrastructure works are well managed and under control, the sponsor can advocate for the project and seek authority where needed, and generally there is an increased likelihood of the project realising the value proposed.

Finally, governance of the DHN project must be integrated into the wider LBH governance framework. LBH's corporate level, where broad council / borough strategy and vision originate, must be effectively managed and integrated with the project's governance and the LBH business as usual operational decisions, to ensure the project has the best chance of approval, support and ultimately success.

A tried and tested way in which appropriate governance can quickly be implemented is through the formation of a project board, with all associated roles in a project delivery/management team. It is our recommendation that LBH should consider forming a project/programme board and in-house management function to provide sufficient governance and oversight for the ongoing scheme(s). This should be made up of:

- Senior members of staff from LBH, one of which can act as a project sponsor, and others including discipline / departmental heads and decision makers;
- LBH subject matter experts, who will support the board internally by providing essential LBH subject matter expertise context to the works and decisions before the board;
- Independent experts from beyond LBH, notionally from engineering institutions or organisations specialising in the DHN works proposed, and ideally several with each able to support the board in different areas e.g. contracting, construction, commercial development, etc.;
- Technical advisors, notionally a team of dedicated engineers and consultants providing resource to the board and capacity to act on the decisions / action generated at board;
- Members of other Local Authorities or entities who have undertaken similar projects;
- Political appointees and councillors, to ensure political buy-in at the earliest point, ensuring appropriate information can cascade down to the communities impacted, and further offering support, advice, and challenge to the board; and finally
- Representatives and independent expertise from central government (BEIS), who are the public sector experts in this field.

15.2 Project Delivery Pathway

To realise any of the proposed networks, the project will go through several further phases of development to refine the technical solution, satisfy economic viability, and seek out network construction and operation partners. Each sequential phase of works serves to de-risk elements of the project to provide confidence to investors – be they private sector or public.

Below, the approximate steps in the project delivery pathway for the LBH heat network have been laid out, forming a high-level guide for the coming stages of work required to get the project through to construction and operation.

15.2.1 Heat Mapping and Masterplanning

The HMMP stage – as undertaken in this study – commences an area-wide exploration for heat network opportunities across Hounslow; identifying and assessing heat loads while cognisant of their proximity to other loads and 'load density'; and identifying key 'anchor' loads for the network(s) which require further engagement and development.

In the case of this specific project, heat loads have been clustered, high level network options have been developed, and initial Techno Economic Models have been produced to assess the relative pros and cons of the network options and undertake initial rankings of the opportunities.

15.2.2 Interim gateway – consultation and agreement to proceed

Following this HMMP study LBH would take the findings to the project sponsor, senior leaders, political appointees, and other stakeholders, deliberating the high-level benefits of progressing the project. Upon decision to progress to fund the next stage, AECOM would support LBH in completing BEIS funding applications to HNDU.

15.2.3 Techno Economic Feasibility

The Techno Economic Feasibility study aims to develop, optioneer, and optimise a single, deliverable heat network solution. The work commences enhanced stakeholder engagement with key anchor loads and stakeholders and conceptual design and modelling, to further understand and de-risk:

The quality of data used at feasibility stage is paramount to increasing the reliability of Techno Economic Model results, usually achieved through obtaining a greater proportion of metered demand data; carrying out further anchor load surveys and engaging with owners and operators to validate assumptions; obtaining and incorporating detailed cost plans for key elements of work (such as specialist road or rail crossings); and obtaining detailed quotations from the electrical grid DNO for connections reinforcement.

By the end of the feasibility study, a stress-tested, feasible, optimised heat network should be designed to a RIBA 2 conceptual design stage. For Hounslow, the feasibility study is expected to commence in Q1 2023 (plus 1 quarter contingency) and is recommended to be run concurrently for several different yet overlapping network options.

AECOM project experience includes 50-100+ Techno Economic Modelling, feasibility assessments, and RIBA 2 conceptual designs for potential heat networks. Most recently in the London area, we've worked on feasibility stage design work for proposed networks in Westminster and Whitehall. For the Whitehall network – a campus style network around buildings with existing DH connectivity – the key feasibility stage outputs included detailed survey and review of all connected loads, plantrooms, and secondary side networks, combined with detailed building-level facilities management engagement. For the Westminster borough-wide network study, the outputs were quite different, with more focus on onboarding and engaging would-be-connections and anchor loads, feasibility testing LZC and EC locations, and creating a deliverable network build-out schedule that could see the £250m+ scheme delivered within the decade.

15.2.4 Interim gateway – consultation and agreement to proceed

Similarly, to post-heat mapping and masterplanning, there will be a period of deliberation and funding applications to prepare for the Detailed Project Development (DPD) phase of works. As before, AECOM would support LBH in completing BEIS funding applications to HNDU.

15.2.5 Detailed Project Development (DPD) and Outline Business Case (OBC)

At the DPD phase of works, a wider team of specialists would be required that at feasibility stage, all working collaboratively to progress LBH's network from a preferred technically feasible solution to an Outline Business Case, suitable for an investment decision by the project board.

The OBC for any public sector entity will typically follow the HM Treasury '5 case' model, including:

- Strategic case: sets out drivers for change, key objects, critical success factors;
- Economic case: identifies and evaluates the options for delivering the strategic needs of the project – options appraisal and selection of best value-for-money option based on scoring of options and Net Present Value analysis of lowest cost option;

- Commercial case: identifies commercial delivery structure, securing financing, procurement strategy;
- Financial case: evaluates the project affordability of the preferred option – impact on revenue and capital budgets, VAT, Tax, and accounting assessment; and
- Management case: project delivery plan, risk register, benefits realisation monitoring.

The team would be composed of several sub teams including:

- Technical engineering: engineers would continue the scheme optioneering and all design engineering activities, inputting into all workstreams.
- Commercial and structuring: Commercial consultants would engage directly with proposed customers with the objective of entering into Memorandums of Understanding (MOU) and ideally Heads of Terms (HOT) as the commercial and financial cases are developed.
- Legal: lawyers would lead the drafting of all contractual documents, HOTs, MOUs, and provide legal advice on property and asset ownership, leasing, contractual delivery, Operation and Maintenance (O&M) contracting, etc.
- Financial: financial consultants / accountants would develop detailed integrated financial models that generate the analysis and financial statements etc. for both the financial and economic cases, taking inputs from both technical engineering teams, and the commercial consultants.

A DPD stage project / OBC submission does not necessarily require that RIBA 3 Developed Designs are generated, but some key areas may be de-risked or designed to a greater extent than RIBA 2 during DPD. This may include more specific pipework

During the DPD, it is common for soft market testing to be undertaken with both potential funders of the works, as well as contractors who may be able to become construction partners. All details gleaned from the market would be used to inform the OBC and support the procurement or funding models selected. For the expected LBH heat network, contractual negotiations

DPD for the LBH network is scheduled for Q1 2024 to Q3 2024 (plus 1 quarter contingency).

AECOM project experience includes 10+ DPD and OBC projects for potential heat networks. Recently in the London area, we've worked on the Haringey Borough-wide DHN, on much a similar scale to that proposed in Hounslow. For Haringey, we assisted the client in preparing and achieving successful sign-off of the project OBC and helping them further secure HNIP funding for the scheme. Currently in Westminster, further to the feasibility study above, we are helping BEIS design, model and develop a delivery model and business structure for the South Westminster Area Wide Network (SWAN), ultimately culminating in the creation of an OBC for the selected lead party organisation – be that BEIS, Westminster CC, Parliament, GPA, or others. Through work with Westminster, AECOM have undertaken extensive stakeholder engagement and consultation with 100's of potential customer sites, and as such are well versed in the various technical and commercial considerations businesses may have prior to connecting to a network.

15.2.6 Commercialisation

Following OBC sign-off from the required project sponsors, commercialisation of the scheme commences. This involves sourcing a RIBA 4 detailed designer and contractor / construction partner to build the network; sourcing or creating an entity to operate the heat network (dependent on chosen delivery model); and finalising customer connections, tariffs, and connection fees.

The network construction is expected to be delivered via a Design and Build contract, with potential for that same private entity also undertaking maintenance and operations, however there are many other routes. The output from commercialisation phase is the fully developed and costed detailed design (RIBA 4) and Full Business Case (FBC) written for LBH's sign off.

Commercialisation is scheduled for Q3 2025 to Q2 2026 (plus 1 quarter contingency). Following FBC sign off, construction may commence. This is scheduled (high level assumption) for Q1 2027.

The proposed project programme is shown in Appendix Q.

15.2.7 Beyond Construction

Following construction, snagging, and commissioning, many DH network roles commence, including the long-term operation and maintenance of the energy network. A graphical illustration of the key roles in the DH network is included below.

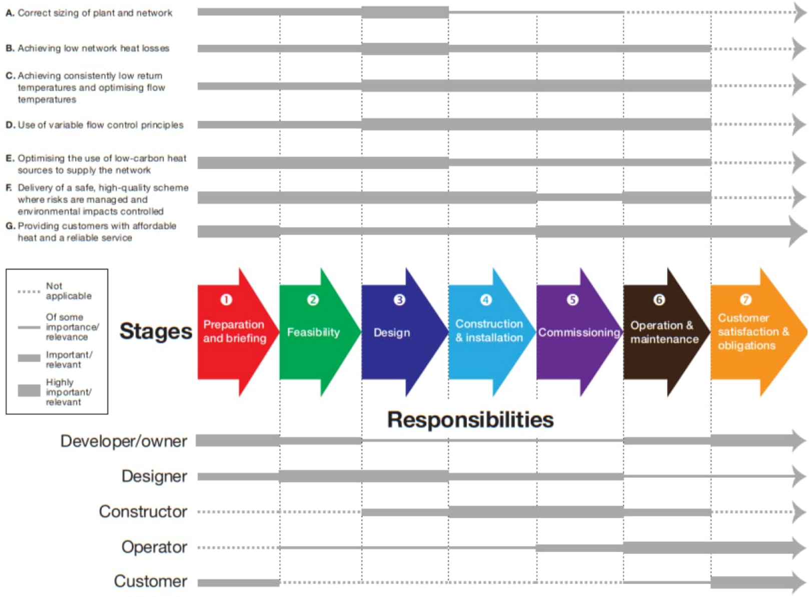


Figure 15-1: DH Network Key Roles[93]

[93] CIBSE Code of Practice: No.1, Heat Networks

Appendix A – Illustrative Overview of Heat Networks

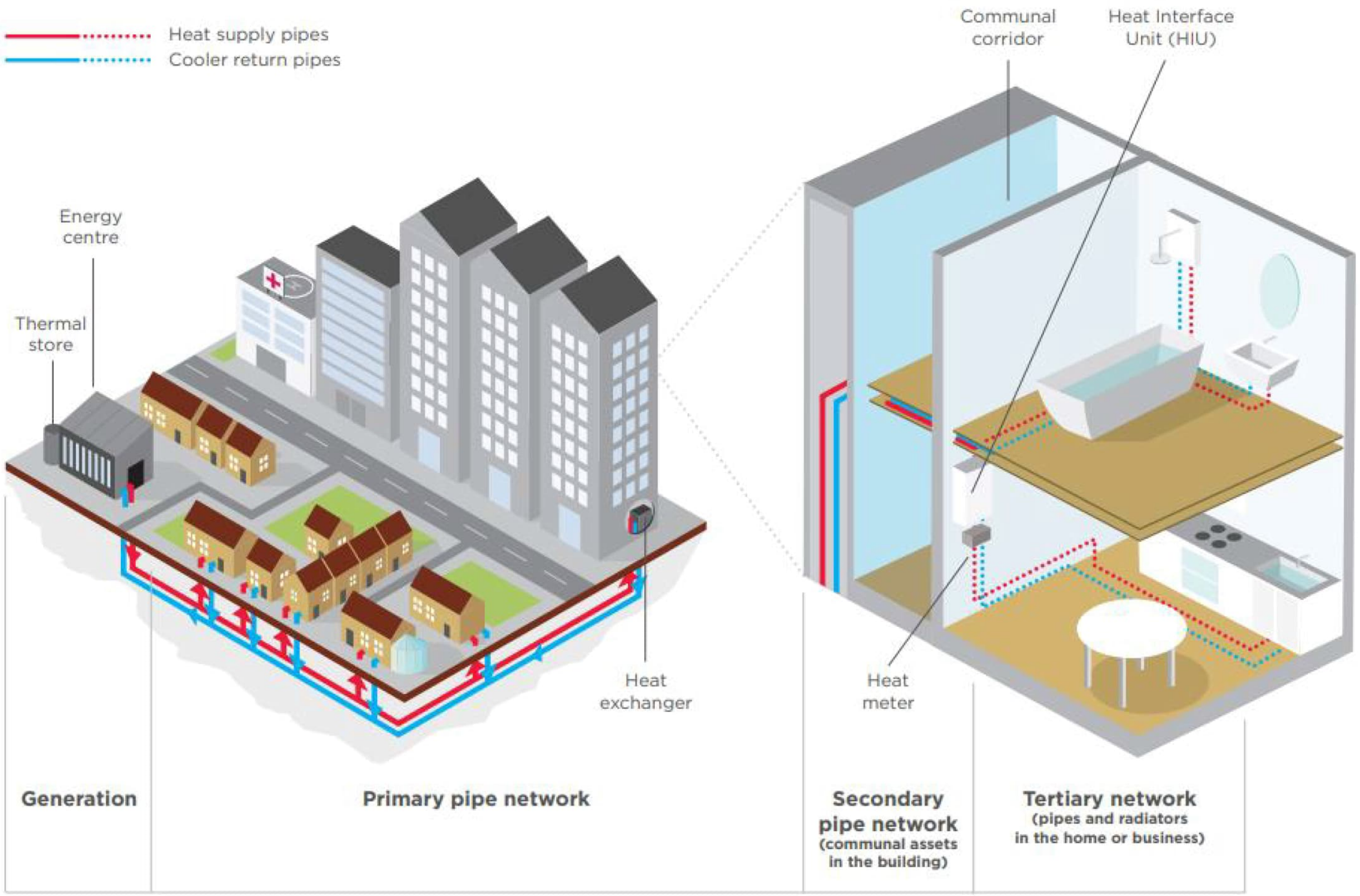
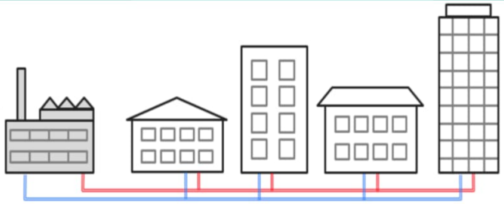
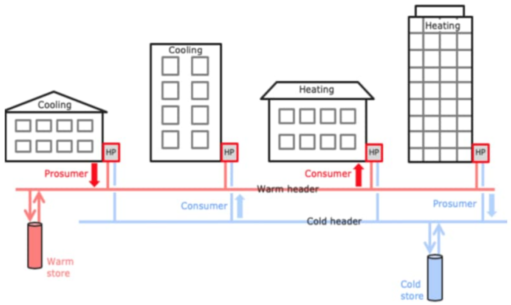
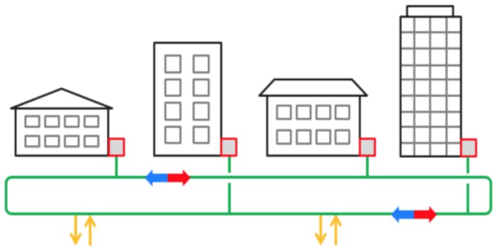


Figure 15-2: Illustrative overview of heat networks

Appendix B – Network Configurations

Table 15-1: Details of Technical Network Configurations

Solution ID	Description	Illustration	System Requirements	'Typical' Operational Temperatures
Third Generation	Heating and cooling is distributed in two different pipework networks, which operate in isolation from one another. Each network has a Flow pipe and a Return pipe.		Can serve either one of or both heating and coolth to any site, including buildings operating with 'historical' heating temperatures of 82/71°C flow and return. If temperature modifications are required, these can be minor.	85-55°C heating network 6-12°C cooling network.
Fourth Generation	Fourth generation heating networks operate at reduced temperatures to enable improved heat pump performance whilst still enabling the generation of domestic hot water instantaneously. Cooling networks are unchanged from Third Gen. Each network has a Flow pipe and a Return pipe		Buildings' heating systems need to operate at lower than 'historical' ones. May require some secondary side conversion works to be undertaken in existing facilities.	60-30°C heating network 6-12°C cooling network.
Fourth Generation with Prosuming	A variant on the fourth-generation system described above, albeit with an element of the generational plant having to be heat pump based to "couple" the heating and cooling. Prosuming describes a type of connection that is both a producer and consumer. When a heat pump operates in heating mode, waste coolth energy is generated, and vice versa. In a 'prosuming' system, this waste energy is recovered within the EC and distributed via the appropriate network, increasing the effective efficiency of the heat pump plant.		Requires both a heating and cooling network in operation, and plant for each system located within the same Energy Centre(s). Can remain suitable even when the heating and cooling loads are unbalanced, i.e. the annual cooling requirements are less than 50% of the heating requirements. Buildings' heating systems need to operate at lower than 'historical' ones. May require some secondary side conversion works to be undertaken in existing facilities.	60-30°C heating network 8-16°C cooling network.
Fifth Generation (Dual Pipe)	This system also includes separate heating and cooling distribution networks, but only a single pipe for each (one heating and one cooling). These networks tend to be of a very low temperature, leading to them being referred to as "Ambient Network". The plant can be two tier in nature; centralised thermal energy generating plant and decentralised (local) prosuming plant. This local prosuming plant can generate heat and coolth at the temperatures required within the building. The rejected heat and coolth from the operation of the local prosuming heat pumps is captured within the appropriate network for use within other sites. Long term 'inter-seasonal' storage can be included to share energy across the typical heating and cooling seasons. The centralised plant acts as 'top-up' plant within centralised energy centre(s). These are able to maintain network temperatures once inter seasonal storage maximum capacities are reached.		Requires both a heating and cooling network in operation. Suitable when the heating and cooling loads are well balanced, i.e. the annual cooling requirements are more than 50% of the heating requirements. Buildings' heating systems need to operate at lower than 'historical' ones. May require some secondary side modification or conversion works to be undertaken in existing facilities.	20°C heating network 15°C cooling network.
Fifth Generation (Single Pipe)	Same generational plant arrangement as above dual pipe fifth generation system, with building-based heat pumps and balancing plant in energy centre(s) if required. However, this system is based on a single pipe solution, which provides the temperature sink for the building-based heat pump when operating in either heating or cooling mode. All rejected energy from heat pump operation can be captured in within the network loop as required.		As above.	15-20°C shared heating and cooling network

Appendix C – Methodology

AECOM's methodology is in-line with the latest HNDU guidance for HMMP stage works and CP1 2022 Stage 2.

C.1 Project Inception

Steps undertaken:

- Issue RFI;
- Inception Meeting;
- Understand Stakeholder's requirements;
- Review red-line boundary;
- Understand proposed development timelines;
- Agreed deadlines for incoming data and stakeholder meetings;
- Discuss possible Energy Centre (EC) Locations;
- Discuss possible network operating regimes;
- Undertake site visits to understand geography and existing building connection requirements;
- Fully understand the drivers behind the project, and subsequently define what success would look like;
- Identify the GHNF aligned counterfactual scenario(s) for the buildings (i.e., the alternative energy system if the heat network does not connect); and
- Identify the preferred approach for the data logging portion of the study;

The inception meeting set expectation and defined success criteria. The Scope was agreed, and deliverables set to ensure that the project was delivered to programme, budget and the satisfaction of the client. Agreement on the lines of communication, goals, methods, and timescales for the project as set out by the AECOM Project Quality Plan (PQP).

Prior to this meeting AECOM prepared a list of the information and data required for the study which was submitted to the project team. This request for information (RFI) included asset management plans, information on current and proposed planning policies and proposed developments in the area, up to date energy consumption data, council owned GIS maps and contact details for key stakeholders.

C.2 Site Surveys: Loads

Site surveys of key anchor load buildings to be connected (Brentford Towers, Brent Lea, Ivybridge, Convent Way, Redwood estates), potential EC locations (Brentford Towers, Brent Lea, Ivybridge, Convent Way) and network routes, were undertaken to ascertain the following:

- To understand the existing system equipment, capacity, condition / expected life expectancy;
- To understand the impact of any planned refurbishment work;
- To better understand the current and future energy requirements;
- To identify the most viable technical solutions for the connection of the buildings to the proposed network(s), and the costs associated;
- Review existing systems to understand the technical challenges in converting 'secondary' networks (heating and, if applicable, cooling and power) to be served by any proposed network(s), and the subsequent costs associated;
- To understand the counterfactual costs associated with generating heating (and cooling, if necessary), taking into account fuel, maintenance, and replacement costs;
- Review the EC locations, understanding the constructability, constraints, and opportunities; and
- Review the network route, including barriers, obstructions, and opportunities.

C.3 Energy Demand Analysis

AECOM carried out an energy demand and supply assessment of the study area, Following the typical steps:

- Received RFI response;
- Analysed existing building data;
- Analysed proposed development data;
- Identified key anchor loads;
- Agree on counterfactual in line with stakeholder commitments and local planning policy.

We located key existing and future energy loads for the following types of buildings: Council buildings; Proposed developments; Schools and Higher Education; Hospitals; Major commercial buildings; Leisure and retail; Industrial/Manufacturing sites; Other public buildings (prisons, libraries, etc). Only future (soon to be developed) residential loads have been included not existing residential with the exception of social housing.

Where possible we obtained metered data from energy/facility managers. Potential customers were engaged to:

- Provide study background and potential benefits;
- Gauge interest;
- Clarify energy needs;
- Determine heating type/temperatures; and
- Arrange site surveys where necessary.

Where data is unavailable, we used data from similar buildings from AECOM modelled data.

The assessment of heating temperatures and subsequent design of network temperature regime was carried out in accordance with CP1 objective 2.4 To select suitable operating temperatures.

Loads were filtered based on criteria such as size of demand, building construction type, suitability to connect to district energy. For future energy demand pre-planning site allocations post-2025 were excluded at the request of the client. At sites were pre-planning site allocations post-2025 are located at an existing building, this existing building were included (as long as there is no other reason for exclusion).

It is important to use good information to increase certainty but at the same time, a clear point must be defined to be able to commence the study. Based on the programme we presented our initial findings at a workshop and discussed a way forward on any critical data/stakeholder issues.

Considerations of demand diversity are made: The undiversified peak power is the sum of the individual peak demands of all buildings, regardless of the time of occurrence. The diversified peak power is the simultaneous peak of all buildings i.e., that which the network must be capable of delivering. Diversity is the ratio of these two values. A smaller diversity ratio translates to greater time variation between peaks and therefore the smaller the centralised energy generation plant can be in comparison to supply each building individually.

C.4 Heat Mapping

- Reviewed energy loads;
- Identified energy clusters for network suitability analysis;
- Produced energy profiles (heat, cool$_{th}$, power);
- Reviewed secondary heat opportunities;
- Reviewed geographic constraints;
- Clustered the heat loads;
- Produced GIS maps (if required).

Upon receipt and review of relevant energy data, we assigned a Quality/Risk Score based on the resolution, sector, and status (existing or future build) of the datasets provided. Proposed new build loads were considered in collaboration with the appropriate planning or development teams.

Loads with unfavourable Quality/Risk Scores were reviewed to ascertain an appropriate method of improving the data set. Mitigation actions were undertaken, but where not possible, deferred to the next stage of assessment and added to the Risk Register. Actions were undertaken at this stage to improve the quality of the assessment such as amending data based on recent refurbishment works etc.

AECOM generated building specific energy demand profiles using our database and toolset based on previous projects to understand how buildings proposed for connection to the network function with regards to energy consumption at each hour of a year.

All collated data was tabulated to provide a numerical and graphical output. A detailed energy map for the study areas produced using GIS, showing heating, cooling and power demand clusters, which highlights the opportunity areas.

This was carried out in accordance with CP1 objective 2.1 - To achieve sufficiently accurate estimates of peak heat demands and annual heat consumptions.

C.5 Energy Centre and Plant Options

- Undertook assessment of LZC technologies;
- Undertook assessment of thermal storage and backup systems;
- Determined capital costs for the EC and network; and
- Developed a clear decarbonisation pathway of identified network.

This was carried out in accordance with CP1 objectives 2.2 - To identify the most suitable low-carbon heat sources and location of an energy centre and 2.3 To determine the location of top-up and standby boilers and use of existing boilers.

C.5.1 LZC Appraisals

A review was undertaken of available technology to test suitability for use in the proposed network. This informed the future/resilient plant selection, with stated capacities, performance, and locations. The assessment looked at the plant section after 15-years of operation, taking in to account the wider decarbonisation pathway, laying out a long-term route map to a zero-carbon.

To assess each technology fairly, they were scored against a range of criteria which are of key concern. These criteria fall into four categories:

- **Technical –** Different technologies have been assessed against their suitability to deliver the scale and the profile of the required heat supply and to operate under required supply temperatures. Examples have been called on to provide evidence of technology maturity and the reliability of the technology's integration with a DHN, while security on fuel delivery has been further considered.
- **Environmental -** A range of environmental implications have been considered for each technology. Direct impacts such as pollution and changes to the local air quality have been discussed for the various technologies. The scale of carbon savings has been estimated based on both current and predicted carbon emission factors. The carbon saving for each technology has been discussed in the context of the fuel used, efficiencies attainable and the relevant emission factors.
- **Financial -** The financial benefit of each technology has been assessed in relation to current and projected fuel prices, efficiency and the expected maintenance level required over the technology's lifetime. Long term financial risks were also considered.
- **Deliverability -** Consideration has been given to the criteria that may affect deliverability of the technology, such as reliance on third parties, and implications on space requirement and energy centre size/design. Technologies were further evaluated based on their suitability on a local level.

Each technology was then scored between 1 and 5 against each criterion and shown in a matrix to determine the most viable technology for the DHN. Scores have been attributed on a comparative basis, with a score of 5 awarded to the highest scoring option in any category and reduced scores awarded in relation to the high scoring option. Using each criterion's weighting importance, the weighted totals were calculated for each technology which allowed the technologies to be ranked. Table 15-2 details each criterion and their given 'Importance', a score between one and five, to reflect its impact on the overall assessment. One represents low importance and five represents high importance. Each criterion is then given a proportional weighting, which is calculated based on the score, such that all weightings sum to 100. The weighting was approved by LB

Table 15-2:Table of LZC scoring criterion and weights.

Category	Criterion	Relative Importance 1 - 5	Weighting %
Technical	Technology maturity and availability	5	9.09
	Suitability for scale and profile of heat demand	5	9.09
	Security of supply	3	5.45
	Suitability for required supply temperatures	4	7.27
	Proximity to heat demands	2	3.64
Environmental	Level of CO_2 emission savings	5	9.09
	Air quality implications	5	9.09
	Wider environmental impacts	2	3.64
Financial	Technology cost	3	5.45
	Impact on scheme financial viability	5	9.09
	Long term financial risks	3	5.45
Deliverability	Planning Implications	4	7.27
	Implications for energy centre size/design	3	5.45
	Implications for additional space requirements	2	3.64
	Reliance on third parties	2	3.64
Operational	Ease and cost of maintenance	2	3.64
			100

C.5.2 Energy Centre Location Appraisals

- Identified the range of potentially suitable Energy Centre(s) locations;
- Identified and assess third-party energy sources that could augment the energy network scheme;
- Identified and assess the technical and economic opportunities to provide private wire customers;
- Undertook appropriate scheme design and provide scale drawings for the energy centre(s);
- Determined the most likely heat supply counterfactual for each customer type.
- Determined CO_2 emissions, air quality management constraints, and undertake a high-level assessment of NO_x and particulates emissions resulting from all viable schemes;
- Undertook a high-level economic assessment of all viable solutions for comparative analysis ('optioneering') to identify the most economically attractive scheme(s); and
- Undertook an initial assessment of existing utilities infrastructure and contacted the utility providers for a budget quotation for the supply of electricity and gas.

Potential locations for the ECs were developed with the Client team and key stakeholders. Considering footprint, volume, operation, and access requirements. AECOM considered the use of third-party sites to house the ECs. Site surveys were carried out to validate these choices were possible.

Table 15-3 details each criterion. Each criterion is then given a proportional weighting, agreed by LBH.

Table 15-3: Table of EC scoring criterion and weights

Criterion	Weighting %
Access	6%
Utility Connections	3%
Implications for Current & Planned Use	3%
Suitability for Flueing	2%
Flood Risk	3%
Access to LZC Sources	13%
Land ownership	6%
Reliance on 3rd parties	6%
Future expansion capability	4%
Proximity to Heat Off takers	13%
Space Availability	8%
Visual Impact	2%
Environmental Impact	3%

Potential to achieve fully electrified solution	9%
Deliverability	6%
Programme Implications	6%
Impact to Residents	5%
Write off cost for existing plant	2%
	100%

C.5.3 Undertake Initial Scheme Design

Supported by the network design (see below) and Initial Economic Assessment (see below) the energy centre design was undertaken. The design of the energy centre enabled an assessment of cost, carbon savings and NO_x impact. The design complies with the relevant CP1 standards.

C.6 Energy Distribution Systems

- Developed scenarios for potential energy networks and create the initial network route maps;
- Undertook an initial compatibility assessment for connection of building systems.
- Ensured future proofing of the network
- Identified significant constraints and developed proposals for how these can be overcome;
- Undertook stakeholder engagement to de-risk.

This was carried out in accordance with CP1 objective 2.5 - To determine heat network distribution routes, pipe sizes and costs.

C.6.1 Constraint Mapping

In order to inform the energy network design, supplementary maps will be produced in GIS to show opportunities and constraints such as:

- Land ownership, classifications, and zoning;
- Physical constraints such as railway lines, canals, brooks, and rivers.
- Conservation areas and other protected areas;
- Environmental constraints including flood risk assessments, Air Quality Management Areas, Green Belt land, National Parks, SSSIs or similar;
- Existing or planned DH networks in the area and other buried utilities.

C.6.2 Identification of Routes & Phasing

Using CP1 and industry best practice, AECOM identified viable routes and options for the opportunity areas. Routes were selected to minimise distance of trenching and therefore cost.

Both mapping and site surveys were used to gauge the civil elements of the works. AECOM assigned a dig type to each section of pipework on the proposed network to reflect the differences in trenching costs between soft dig (grass), sub-urban dig, urban dig, extra urban dig, and specialist crossing. This improved the validity of the initial cost estimates for the project.

By assessing limiting factors to construction such as labour availability, rate of pipe installs and contingency planning, a realistic phasing schedule was developed describe to the network rollout and connection of each load over time. This is aligned to the decarbonisation targets and expected future skills capacity.

Phasing was carried out in accordance with CP1 objective 2.7 - To minimise the negative impacts of phasing the development.

C.7 Techno-economic Assessment

- Ascertained high level costs and revenue streams;
- Carried out initial Techno-Economic Model for the opportunities;
- Determined the Internal Rate of Return (IRR), Net Present Value (NPV) and Levelised Cost of Energy (LCoE) for all solutions being considered;
- Undertook sensitivity analysis in line with Table 1 of the HNDU Feasibility specification, plus custom sensitivities;
- Determined the gap funding requirements; and
- Tracked key risks / issues associated with each option.

An Initial Economic Assessment was carried out to provide a quantitative assessment of the proposed networks. The assessments reflected the revenue streams, CapEx, OpEx and RepEx for the networks being considered.

The TEM systematically analyses various permutations of energy sources and connected buildings to inform decision-making. This process is crucial for analysing the energy centre size, plant, and network connections.

Appropriate counterfactual options aligned to green heat network fund recommendations were developed for each load to allow comparison of the scheme to the economic and environmental performance without intervention. The output of the TEM provided the economic metrics that assisted in the identification of any funding gaps to provide a robust, financeable solution.

Techno-economic modelling was carried out in accordance with CP1 objectives:

- 2.6 - To determine building connection costs, including heat metering.
- 2.8 - To assess lifecycle operation, maintenance and replacement requirements, costs, and revenues.
- 2.9 - To conduct a consistent economic analysis and options appraisal.
- 2.10 - To analyse risks and carry out a sensitivity analysis.
- 2.11 - To assess environmental impacts and benefits.

C.8 Heat Mapping and Masterplanning Outputs

Based on the methodology above AECOM:

- Prepared a report on the above;
- Produced a high-level executive summary;
- Prepared 'route map' to show how the networks could be built;
- Completed the CP1 checklist and statement of applicability.
- Identified the next steps for the project and advised LBH;
- Produced GIS maps and model inputs;
- Complete the Risks, Assumptions & Opportunities Log.

The findings for each masterplan area were summarised, alongside the required heat maps and other data results, in an easy-to-understand technical report (this report). A standalone executive summary has also been provided to support communication of the project to LBH councillors.

Appendix D – Energy Load Information

For heat networks to be financially viable, significant heat demand is required to justify the capital expense of installing the required pipework to distributed heating between buildings. Therefore, it is important to identify clusters of buildings with a high density of heating demand. Heating demand has been obtained from a variety of sources with the order of priority given by the below diagram.

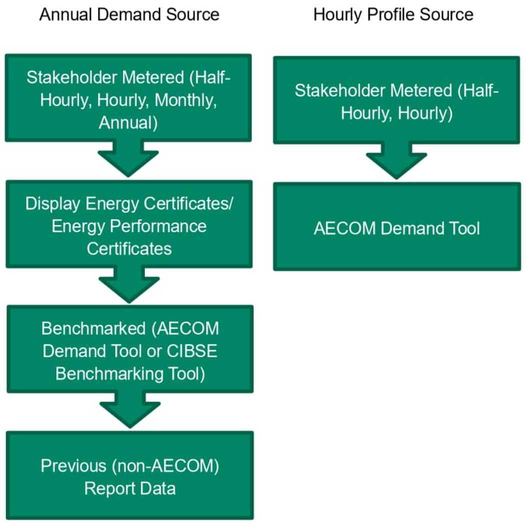


Figure 15-3: Diagram showing data source order of priority for annual heat demand and heat demand profile

Stakeholder metered data is considered the most accurate and reliable data source. Display Energy Certificates (DECs) and non-domestic Energy Performance Certificates (EPCs) are accurate since they are based on metered or estimated data from the time of the assessment, however, do not provide granular hourly profiles. Remaining loads have been benchmarked using real or estimated GIA's (gross internal floor area) and the benchmarks detailed in Table 15-4.

Use Type	Annual Heat Demand (kWh/m^2)	Data Source	Peak Load (W/m^2)	Data Source

Table 15-4: Table of benchmarks used to determine heat demand of buildings by use type

For all data provided in terms of gas usage, heat demand is determined from gas boiler efficiency of ~90% for new boilers and ~86% for old boilers. In future project stages a more bespoke assessment of plant life and combustion efficiency will be undertaken.

Buildings in the DEC database less then 100MWh/annum and buildings in the EPC database less than 1,000m^2 GIA were filtered to remove smaller buildings and have not been analysed or recorded unless the building is owned/operated by London Borough of Hounslow. These filters remove small individual residential buildings and small commercial units.

A data quality score has been assigned to each load which is comprised of factors detailed in

Table 15-5. The average data quality across all loads included in at least one proposed network is 52.5%. This value is acceptable for the current stage and will be increased at feasibility stage with enhanced stakeholder engagement.

Factor	Value	% Weighting
Annual Demand Source	Stakeholder Metered	**40%**
	DEC/EPC	30%
	Benchmark	20%
	Previous (non-AECOM) Report	10%
Source Date	>=2018	**20%**
	<2018	0%
Hourly Profile Source	Stakeholder Metered	**40%**
	AECOM Demand Tool	20%

Table 15-5: Table showing weighting of factors included in the data quality score

All cooling data has been benchmarked using real or estimated GIA's (gross internal floor area) and the benchmarks detailed in Table 15-6.

Use Type	Annual Cool Demand (kWh/m²)	Benchmark Source

Table 15-6: Table of benchmarks used to determine coolth demand of buildings by use type

For some council loads metered electricity data has been obtained. When the age of data pre-dates a decarbonisation measure such as the install of a heat pump, electrical demand has been adjusted to account for the increase. This was achieved calculating the electrical input required to utilise the full heat pump capacity (provided by LBH) for 68% of the time, assuming a coefficient of performance of 2.5. All other loads have been benchmarked using real or estimated GIA's (gross internal floor area) with benchmarks detailed in. Table 15-7.

Use Type	Annual Electricity Demand (kWh/m²)	Benchmark Source

Table 15-7: Table of benchmarks used to determine electricity demand by use type

Appendix E – Identified Heat Loads

Included loads are shown in Table 15-8 and excluded loads are shown in Table 15-9 Please also see Appendix G which details a subset of excluded loads for which we do not have energy demand data

ID	Load Name	Cluster	Included in Complete Borough Network?	Annual Heat Demand (kWh)	Undiversified Peak Heat Demand (kW)	Counterfactual (heating source and flow temperature)
1	1 Lampton Road	1 Hounslow Town Centre	yes	542,754	380	Gas Boilers, 75°
2	12-32 Lampton Road (Lampton Rise)	1 Hounslow Town Centre	yes	338,109	237	Gas Boilers, 75°
3	206-210 Hanworth Road (existing) - Treaty Lodge Hotel	1 Hounslow Town Centre	yes	164,450	69	Gas Boilers, 75°
7	34 Staines Road Hounslow (new) Development	1 Hounslow Town Centre	yes	774,416	494	Air Source Heat Pump, 55°
9	714-746 London Road (Charter Place, Ostler's Court)	1 Hounslow Town Centre	yes	1,375,819	937	Gas Boilers, 75°
10	80-82 Staines Road (existing) - Xercise4Less Gym	1 Hounslow Town Centre	yes	502,500	125	Gas Boilers, 75°
14	Blenheim Centre Hounslow	1 Hounslow Town Centre	yes	2,328,000	858	Air Source Heat Pump, 75°
16	Central House Serviced Apartments	1 Hounslow Town Centre	yes	536,000	375	Gas Boilers, 75°
19	Cromwell Estate	1 Hounslow Town Centre	yes	1,219,400	854	Gas Boilers, 75°
20	Euro House (existing)	1 Hounslow Town Centre	yes	308,629	144	Air Source Heat Pump, 75°
22	Falcon House	1 Hounslow Town Centre	yes	228,208	106	Air Source Heat Pump, 75°
23	Frogley House	1 Hounslow Town Centre	yes	415,143	291	Gas Boilers, 75°
25	Golds Gym (within Continental Hotel)	1 Hounslow Town Centre	yes	32,806	14	Air Source Heat Pump, 75°
26	Greenham House	1 Hounslow Town Centre	yes	486,896	341	Gas Boilers, 75°
30	Heart of Hounslow Health Centre	1 Hounslow Town Centre	yes	1,275,372	594	Air Source Heat Pump, 75°
32	High Street Quarter Development	1 Hounslow Town Centre	yes	4,436,214	2680	Air Source Heat Pump, 55°
33	Holdsworth House	1 Hounslow Town Centre	yes	207,746	97	Air Source Heat Pump, 75°
35	Hounslow Central Hotel	1 Hounslow Town Centre	yes	135,135	57	Gas Boilers, 75°
36	Hounslow House	1 Hounslow Town Centre	yes	1,921,073	909	Air Source Heat Pump, 75°
37	Hounslow Library	1 Hounslow Town Centre	yes	231,115	117	Air Source Heat Pump, 75°
38	Hounslow Police Station	1 Hounslow Town Centre	yes	329,472	102	Air Source Heat Pump, 75°
39	Hounslow Town Primary	1 Hounslow Town Centre	yes	976,000	555	Air Source Heat Pump, 75°
41	Hyde House Estate	1 Hounslow Town Centre	yes	572,708	401	Gas Boilers, 75°
42	Ibis Hotel	1 Hounslow Town Centre	yes	500,500	211	Air Source Heat Pump, 75°
44	Inwood Business Park (new) Development	1 Hounslow Town Centre	yes	540,504	240	Air Source Heat Pump, 55°
46	Kingsley Academy	1 Hounslow Town Centre	yes	922,925	525	Air Source Heat Pump, 75°
47	Kingsley Road Youth Centre (existing)	1 Hounslow Town Centre	yes	64,200	22	Air Source Heat Pump, 75°
51	Land at Bell Road Development	1 Hounslow Town Centre	yes	652,470	424	Air Source Heat Pump, 55°
54	Land at Hanworth Road Development	1 Hounslow Town Centre	yes	400,392	280	Gas Boilers, 75°
55	Land at James Street Development	1 Hounslow Town Centre	yes	311,416	218	Gas Boilers, 75°
56	LBH Council: Vehicle maintenance Bridge Road	1 Hounslow Town Centre	yes	481,265	224	Air Source Heat Pump, 75°
57	Montague Hall	1 Hounslow Town Centre	yes	52,483	24	Air Source Heat Pump, 75°
62	Phoenix House	1 Hounslow Town Centre	yes	939,800	438	Air Source Heat Pump, 75°
63	Quest House	1 Hounslow Town Centre	yes	231,801	108	Air Source Heat Pump, 75°
64	Ramada by Wyndham Hotel	1 Hounslow Town Centre	yes	471,900	199	Air Source Heat Pump, 75°

ID	Load Name	Cluster	Included in Complete Borough Network?	Annual Heat Demand (kWh)	Undiversified Peak Heat Demand (kW)	Counterfactual (heating source and flow temperature)
65	Royal Mail Delivery Office (existing)	1 Hounslow Town Centre	yes	330,912	157	Air Source Heat Pump, 75°
67	Sceptre House	1 Hounslow Town Centre	yes	137,378	64	Air Source Heat Pump, 75°
69	St Marks School (6no. DECs)	1 Hounslow Town Centre	yes	698,322	397	Air Source Heat Pump, 75°
71	Star Road Estate	1 Hounslow Town Centre	yes	911,048	638	Gas Boilers, 75°
72	The Continental Hotel	1 Hounslow Town Centre	yes	429,000	181	Air Source Heat Pump, 75°
73	The Everglades	1 Hounslow Town Centre	yes	197,908	139	Gas Boilers, 75°
75	The Star Centre	1 Hounslow Town Centre	yes	84,697	39	Air Source Heat Pump, 75°
76	The Treaty Centre	1 Hounslow Town Centre	yes	776,000	286	Air Source Heat Pump, 75°
77	Travelodge	1 Hounslow Town Centre	yes	572,000	241	Air Source Heat Pump, 75°
78	Triangle Day Centre	1 Hounslow Town Centre	yes	73,304	42	Gas Boilers, 75°
79	Trinity Square	1 Hounslow Town Centre	yes	536,000	375	Gas Boilers, 75°
502	Heston Fire Station	1 Hounslow Town Centre	yes	293,615	167	Air Source Heat Pump, 75°
503	Isleworth & Syon School	1 Hounslow Town Centre	yes	785,627	447	Air Source Heat Pump, 75°
505	Isleworth Crown Court	1 Hounslow Town Centre	yes	1,501,794	780	Air Source Heat Pump, 75°
543	West Thames College: Atrium & Millennium Building	1 Hounslow Town Centre	yes	565,753	333	Air Source Heat Pump, 75°
544	West Thames College: Sir Joseph Banks Building	1 Hounslow Town Centre	yes	276,131	162	Air Source Heat Pump, 75°
545	West Thames College: Spring Grove House	1 Hounslow Town Centre	yes	86,980	51	Air Source Heat Pump, 75°
85	Beavers Community Primary School: New Sports Complex	2 Central and Hounslow West	yes	367,683	209	Air Source Heat Pump, 75°
87	Benham Gardens Estate	2 Central and Hounslow West	yes	197,745	138	Gas Boilers, 75°
88	Boswood Court	2 Central and Hounslow West	yes	602,148	422	Gas Boilers, 75°
89	Clements Court Estate	2 Central and Hounslow West	yes	556,100	389	Gas Boilers, 75°
91	Cooper House, Maitland Close	2 Central and Hounslow West	yes	762,538	534	Gas Boilers, 75°
92	Eaton House	2 Central and Hounslow West	yes	351,000	164	Air Source Heat Pump, 75°
97	George Chatt House	2 Central and Hounslow West	yes	1,339,272	938	Gas Boilers, 75°
99	Heath Court	2 Central and Hounslow West	yes	653,950	458	Gas Boilers, 75°
100	Heathrow Corporate Park	2 Central and Hounslow West	yes	5,566,752	2647	Air Source Heat Pump, 75°
102	Heathrow International Trading Estate (new) Development	2 Central and Hounslow West	yes	1,728,000	822	Air Source Heat Pump, 55°
104	Hounslow Cavalry Barracks	2 Central and Hounslow West	yes	4,500,000	2403	Air Source Heat Pump, 75°
105	Hounslow Education Centre	2 Central and Hounslow West	yes	211,000	120	Air Source Heat Pump, 75°
106	Hounslow Heath Infant and Nursery School	2 Central and Hounslow West	yes	173,568	99	Air Source Heat Pump, 75°
115	Land at Former Travis Perkins Site 379-389 Staines Road Development	2 Central and Hounslow West	yes	144,656	80	Air Source Heat Pump, 55°
119	Lascar Works Site, Staines Road Development	2 Central and Hounslow West	yes	209,094	146	Gas Boilers, 75°
121	Maitland Close Estate	2 Central and Hounslow West	yes	127,300	89	Gas Boilers, 75°
124	Midsummer Avenue Estate	2 Central and Hounslow West	yes	1,545,699	1082	Gas Boilers, 75°
125	Old Farm Close Estate	2 Central and Hounslow West	yes	299,092	209	Gas Boilers, 75°
130	Sycamore Court	2 Central and Hounslow West	yes	524,984	368	Gas Boilers, 75°
133	The Heathland School	2 Central and Hounslow West	yes	1,077,715	613	Air Source Heat Pump, 75°
134	The Hub Community Centre	2 Central and Hounslow West	yes	28,800	10	Air Source Heat Pump, 75°

ID	Load Name	Cluster	Included in Complete Borough Network?	Annual Heat Demand (kWh)	Undiversified Peak Heat Demand (kW)	Counterfactual (heating source and flow temperature)
135	The Meadows Centre for Health	2 Central and Hounslow West	yes	250,860	117	Air Source Heat Pump, 75°
136	The Vista Centre	2 Central and Hounslow West	yes	1,215,627	566	Air Source Heat Pump, 75°
137	Tivoli Road Estate	2 Central and Hounslow West	yes	2,254,443	1578	Gas Boilers, 75°
139	Wellington Day Centre	2 Central and Hounslow West	yes	3,868,281	1319	Air Source Heat Pump, 75°
141	4 Hayes Road	3 Cranford and Heston West		496,621	231	Air Source Heat Pump, 75°
146	Berkeley Academy	3 Cranford and Heston West		285,000	162	Air Source Heat Pump, 75°
150	Convent Way Estate (existing)	3 Cranford and Heston West		1,957,472	1370	Gas Boilers, 75°
152	Cranford Community School	3 Cranford and Heston West		1,428,473	812	Air Source Heat Pump, 75°
155	David Lloyd Heston	3 Cranford and Heston West		5,610,920	2361	Air Source Heat Pump, 75°
157	Double Tree by Hilton	3 Cranford and Heston West		1,352,780	569	Air Source Heat Pump, 75°
158	Harlech Gardens Estate	3 Cranford and Heston West		1,500,800	1051	Gas Boilers, 75°
159	Heathrow House	3 Cranford and Heston West		796,620	371	Air Source Heat Pump, 75°
165	Hounslow Montessori Nursery & Pre-school (Khosla House II)	3 Cranford and Heston West		169,100	96	Gas Boilers, 75°
169	Meadowbank Adult Education	3 Cranford and Heston West		118,186	67	Air Source Heat Pump, 75°
170	Moxy London	3 Cranford and Heston West		1,859,000	782	Air Source Heat Pump, 75°
171	Norman Crescent Estate	3 Cranford and Heston West		347,006	243	Gas Boilers, 75°
176	QPR Football Academy (Concord Centre)	3 Cranford and Heston West		476,000	137	Air Source Heat Pump, 75°
178	Redwood Estate	3 Cranford and Heston West		3,579,216	2506	Gas Boilers, 75°
179	Springwell Infants & Nursery School	3 Cranford and Heston West		263,422	150	Gas Boilers, 75°
182	The London College (Khosla House II)	3 Cranford and Heston West		62,252	37	Air Source Heat Pump, 75°
185	Ibis Heathrow Central	3 Cranford and Heston West		1,716,000	722	Air Source Heat Pump, 75°
186	Travelodge London Heathrow Heston M4 Westbound	3 Cranford and Heston West		715,000	301	Air Source Heat Pump, 75°
132	Tesco Dukes Green Avenue (new) Development	4 Feltham	yes	2,041,988	1159	Air Source Heat Pump, 55°
189	2A Kinex, Plane Tree Crescent	4 Feltham	yes	234,300	109	Air Source Heat Pump, 55°
190	61 Fern Grove (new) Development	4 Feltham	yes	266,928	187	Gas Boilers, 75°
191	80-86 High Street Feltham (existing) - Aldi	4 Feltham	yes	391,500	144	Air Source Heat Pump, 75°
195	Anytime Fitness Feltham	4 Feltham	yes	99,294	25	Gas Boilers, 75°
201	Bedfont Children's Centre	4 Feltham	yes	12,336	7	Gas Boilers, 75°
203	Berkshire House, 3 Maple Way	4 Feltham	yes	144,000	68	Air Source Heat Pump, 55°
206	Browells Lane (existing)	4 Feltham	yes	288,000	137	Air Source Heat Pump, 75°
210	Cardinal Road Infant & Nursery School	4 Feltham	yes	306,035	174	Air Source Heat Pump, 75°
212	Council Depot, Ashmead Road (existing)	4 Feltham	yes	208,508	97	Air Source Heat Pump, 75°
215	CRC Bedfont Office	4 Feltham	yes	11,636	5	Air Source Heat Pump, 75°
218	Edward Pauling House	4 Feltham	yes	668,729	468	Gas Boilers, 75°
222	Fairholm School	4 Feltham	yes	668,440	380	Air Source Heat Pump, 75°
224	Feltham Centre for Health	4 Feltham	yes	234,490	109	Air Source Heat Pump, 75°
227	Feltham Constitutional Club	4 Feltham	yes	182,542	62	Air Source Heat Pump, 75°
228	Feltham Corporate Centre	4 Feltham	yes	859,100	400	Air Source Heat Pump, 55°

ID	Load Name	Cluster	Included in Complete Borough Network?	Annual Heat Demand (kWh)	Undiversified Peak Heat Demand (kW)	Counterfactual (heating source and flow temperature)
229	Feltham Delivery Office Unit, 2 Plane Tree Crescent	4 Feltham	yes	136,301	65	Air Source Heat Pump, 75°
230	Feltham Hill Infant & Nursery School	4 Feltham	yes	294,464	167	Air Source Heat Pump, 75°
231	Feltham Library/The Centre	4 Feltham	yes	161,494	82	Air Source Heat Pump, 75°
235	Feltham Magistrates Court	4 Feltham	yes	146,318	76	Air Source Heat Pump, 75°
236	Feltham North Children's Centre aka Alf King Centre	4 Feltham	yes	36,039	20	Gas Boilers, 75°
237	Feltham Police Station	4 Feltham	yes	165,344	51	Air Source Heat Pump, 75°
243	Hanover House, Plane Tree Crescent	4 Feltham	yes	195,250	91	Air Source Heat Pump, 55°
244	Hanworth Air Park Leisure Centre & Library	4 Feltham	yes	1,926,476	744	Air Source Heat Pump, 75°
245	Hanworth Youth Centre	4 Feltham	yes	111,506	38	Air Source Heat Pump, 75°
249	Highfields & Homecourt Estate	4 Feltham	yes	2,210,577	1548	Gas Boilers, 75°
250	HMP/YOI Feltham	4 Feltham	yes	13,452,696	1353	Air Source Heat Pump, 75°
253	Land Adjacent to Tesco Manor Lane Development	4 Feltham	yes	462,675	324	Gas Boilers, 75°
255	Land at Feltham Magistrates Court Development	4 Feltham	yes	124,566	87	Gas Boilers, 75°
257	Land at New Road Triangle Development	4 Feltham	yes	489,368	343	Gas Boilers, 75°
262	Lavender Court Estate	4 Feltham	yes	538,163	377	Gas Boilers, 75°
263	Leisure West (existing)	4 Feltham	yes	2,607,360	961	Gas Boilers, 75°
265	Lidl Feltham (existing)	4 Feltham	yes	716,184	264	Air Source Heat Pump, 75°
267	Lindon Bennett Specialist Nursery	4 Feltham	yes	637,263	362	Gas Boilers, 75°
268	Longford Community School / Rivers Academy West	4 Feltham	yes	1,472,400	837	Air Source Heat Pump, 75°
271	Manor Park (existing)	4 Feltham	yes	388,000	143	Air Source Heat Pump, 75°
276	MOD Feltham (existing)	4 Feltham	yes	1,972,000	933	Air Source Heat Pump, 75°
278	Network House Feltham (new) Development	4 Feltham	yes	889,760	623	Gas Boilers, 75°
279	New Chapel Square Estate	4 Feltham	yes	2,276,000	1593	Gas Boilers, 75°
282	Nursery Close Estate	4 Feltham	yes	300,000	210	Gas Boilers, 75°
283	Oak Hill Academy West London	4 Feltham	yes	300,688	171	Air Source Heat Pump, 75°
284	Oriel Academy West London	4 Feltham	yes	416,542	237	Air Source Heat Pump, 75°
285	Oriel Estate (blocks)	4 Feltham	yes	3,921,694	2745	Gas Boilers, 75°
286	Owen House	4 Feltham	yes	435,176	305	Gas Boilers, 75°
288	Pinewood Road Estate	4 Feltham	yes	527,033	369	Gas Boilers, 75°
290	Reach Academy	4 Feltham	yes	136,504	60	Air Source Heat Pump, 75°
291	Rose Gardens & Manor Lane Estate	4 Feltham	yes	17,037	12	Gas Boilers, 75°
292	Russell Finnex	4 Feltham	yes	624,000	297	Air Source Heat Pump, 75°
294	Sandalwood Road Estate	4 Feltham	yes	453,778	318	Gas Boilers, 75°
295	Sandbanks Resource Centre	4 Feltham	yes	774,397	542	Gas Boilers, 75°
297	Shore Close Estate	4 Feltham	yes	294,800	206	Gas Boilers, 75°
299	Smith House, Elmwood Avenue (new) Development	4 Feltham	yes	889,760	623	Gas Boilers, 75°
302	South Ville Community Centre	4 Feltham	yes	85,600	29	Air Source Heat Pump, 75°
303	Southville Infants & Junior School	4 Feltham	yes	348,696	198	Air Source Heat Pump, 75°

ID	Load Name	Cluster	Included in Complete Borough Network?	Annual Heat Demand (kWh)	Undiversified Peak Heat Demand (kW)	Counterfactual (heating source and flow temperature)
305	Sparrow Farm Infants & Primary School	4 Feltham	yes	132,197	75	Air Source Heat Pump, 75°
307	Spring West Academy	4 Feltham	yes	1,171,083	666	Air Source Heat Pump, 75°
310	St. Catherine's House (new) Development	4 Feltham	yes	128,106	79	Gas Boilers, 75°
311	St. Giles Hotel	4 Feltham	yes	2,860,000	1204	Air Source Heat Pump, 75°
312	St. Lawrence R C School	4 Feltham	yes	269,270	153	Air Source Heat Pump, 75°
315	Surrey House, Plane Tree Crescent	4 Feltham	yes	234,300	109	Air Source Heat Pump, 55°
316	Sussex House, Plane Tree Crescent	4 Feltham	yes	624,800	291	Air Source Heat Pump, 55°
319	Tesco Feltham - 98 High Street (new) Development	4 Feltham	yes	2,003,716	1072	Air Source Heat Pump, 75°
322	The Hollands Estate	4 Feltham	yes	1,965,091	1376	Gas Boilers, 75°
323	The Longford Centre: "The Centre"	4 Feltham	yes	6,308,674	2031	Air Source Heat Pump, 75°
326	UPS House (existing)	4 Feltham	yes	215,040	102	Air Source Heat Pump, 75°
328	Vector Park	4 Feltham	yes	729,600	347	Air Source Heat Pump, 75°
329	Victoria Junior School	4 Feltham	yes	170,466	97	Air Source Heat Pump, 75°
331	Warwick House, Plane Tree Crescent	4 Feltham	yes	351,450	164	Air Source Heat Pump, 55°
332	Waterloo Estate	4 Feltham	yes	4,516,051	3161	Gas Boilers, 75°
333	Watermead Estate	4 Feltham	yes	1,045,200	732	Gas Boilers, 75°
334	West London Family Court	4 Feltham	yes	193,752	101	Air Source Heat Pump, 75°
335	West Thames College: Skills + Logistics Centre	4 Feltham	yes	280,458	165	Air Source Heat Pump, 75°
337	1020 Great West Road (existing) - Toyota	5 Brentford	yes	57,600	27	Air Source Heat Pump, 75°
340	125 Harlequin Avenue (existing) - Classic Cars	5 Brentford	yes	96,000	46	Air Source Heat Pump, 75°
342	2 Harlequin Avenue (existing)	5 Brentford	yes	67,200	32	Air Source Heat Pump, 75°
345	40 and 40A High Street (Albany Riverside) Development	5 Brentford	yes	858,618	601	Gas Boilers, 75°
348	931 Great West Road (new) Development	5 Brentford	yes	422,400	201	Air Source Heat Pump, 55°
349	971 Great West Road (existing) - DFS	5 Brentford	yes	543,200	200	Air Source Heat Pump, 75°
352	Aparthotel Adagio London Brentford	5 Brentford	yes	2,402,400	1011	Air Source Heat Pump, 75°
353	B&Q Chiswick (new) Development	5 Brentford	yes	3,625,423	1912	Air Source Heat Pump, 55°
356	Bolder Academy	5 Brentford	yes	190,880	55	Air Source Heat Pump, 75°
359	Brent Lea and Danehurst (communal)	5 Brentford	yes	2,239,000	1567	Gas Boilers, 75°
361	Brentford County Court	5 Brentford	yes	137,045	71	Air Source Heat Pump, 75°
362	Brentford Day Nursery (Half Acre)	5 Brentford	yes	103,000	59	Gas Boilers, 75°
363	Brentford Docks Estate	5 Brentford	yes	2,278,000	1595	Gas Boilers, 75°
364	Brentford FC Community Stadium	5 Brentford	yes	870,400	357	Air Source Heat Pump, 75°
365	Brentford FC Community Stadium Residential Development	5 Brentford	yes	4,368,722	3058	Air Source Heat Pump, 55°
368	Brentford Fountains Leisure Centre (new) Development	5 Brentford	yes	1,884,449	1176	Air Source Heat Pump, 55°
370	Brentford Group Practice (new) Development	5 Brentford	yes	271,377	190	Gas Boilers, 75°
371	Brentford Library	5 Brentford	yes	144,431	73	Air Source Heat Pump, 75°
372	Brentford Lock West Commerce Road Development	5 Brentford	yes	1,456,753	996	Air Source Heat Pump, 55°
373	Brentford Project Development	5 Brentford	yes	8,059,549	4605	Air Source Heat Pump, 55°

ID	Load Name	Cluster	Included in Complete Borough Network?	Annual Heat Demand (kWh)	Undiversified Peak Heat Demand (kW)	Counterfactual (heating source and flow temperature)
374	Brentford School for Girls	5 Brentford	yes	2,444,000	1389	Air Source Heat Pump, 75°
376	Brentside Park (new) Development	5 Brentford	yes	2,706,324	1532	Air Source Heat Pump, 55°
391	EMC Tower (existing)	5 Brentford	yes	781,000	364	Air Source Heat Pump, 75°
394	Fenn House Lodge	5 Brentford	yes	617,273	432	Gas Boilers, 75°
395	Former Alfa Lavel Site (other business)	5 Brentford	yes	365,274	141	Air Source Heat Pump, 75°
396	Former Alfa Lavel Site (resi & micro business)	5 Brentford	yes	960,685	664	Gas Boilers, 75°
397	Former Brentford Police Station Development	5 Brentford	yes	929,424	522	Air Source Heat Pump, 55°
398	Former Citroen Site Capital Interchange Way Development	5 Brentford	yes	2,124,678	1446	Air Source Heat Pump, 55°
400	Gillette Building Studios (existing)	5 Brentford	yes	2,250,000	1070	Air Source Heat Pump, 75°
402	Goddards, The Ham Development	5 Brentford	yes	364,800	173	Air Source Heat Pump, 55°
403	Great West house	5 Brentford	yes	1,124,640	524	Air Source Heat Pump, 75°
406	Green Dragon Lane Estate - Brentford Towers and Harnage House (communal)	5 Brentford	yes	6,903,326	4833	Gas Boilers, 75°
409	Griffin Court	5 Brentford	yes	255,200	179	Gas Boilers, 75°
410	Griffin Park Stadium Redevelopment	5 Brentford	yes	333,660	234	Gas Boilers, 75°
411	GSK 980 Great West Road	5 Brentford	yes	7,263,300	3383	Air Source Heat Pump, 75°
415	Holiday Inn Brentford Lock	5 Brentford	yes	700,700	295	Air Source Heat Pump, 75°
416	Holly House Estate	5 Brentford	yes	180,632	126	Gas Boilers, 75°
417	Homebase Syon Lane (new) Development	5 Brentford	yes	3,782,382	2274	Air Source Heat Pump, 55°
418	Kew Bridge Road and Thameside Centre	5 Brentford	yes	1,000,000	466	Air Source Heat Pump, 75°
419	Kia 963 Great West Road	5 Brentford	yes	576,000	274	Air Source Heat Pump, 75°
420	Lambert Lodge	5 Brentford	yes	611,978	428	Gas Boilers, 75°
435	Layton road Warehouses (new) Development	5 Brentford	yes	177,952	125	Gas Boilers, 75°
439	London Museum of Water & Steam	5 Brentford	yes	34,352	10	Air Source Heat Pump, 75°
440	Marlborough School	5 Brentford	yes	388,713	221	Air Source Heat Pump, 75°
444	Mille Building (existing)	5 Brentford	yes	710,710	331	Air Source Heat Pump, 75°
446	Morrison's 228-246 High Street (new) Development	5 Brentford	yes	1,790,807	1072	Air Source Heat Pump, 55°
448	Novotel London Brentford	5 Brentford	yes	1,001,000	421	Air Source Heat Pump, 75°
454	Parkview Development	5 Brentford	yes	1,299,050	909	Gas Boilers, 75°
455	Pets at Home Brentford	5 Brentford	yes	313,200	115	Air Source Heat Pump, 75°
459	Premier Inn Brentford	5 Brentford	yes	572,000	241	Air Source Heat Pump, 75°
460	Premier Inn Kew Bridge	5 Brentford	yes	806,520	339	Air Source Heat Pump, 75°
462	Q West	5 Brentford	yes	393,761	183	Air Source Heat Pump, 75°
465	Sky Campus (existing)	5 Brentford	yes	5,467,000	2547	Air Source Heat Pump, 75°
466	Sky Campus (new) Development	5 Brentford	yes	4,061,200	1892	Air Source Heat Pump, 55°
469	St. Pauls CE Primary School	5 Brentford	yes	248,009	141	Air Source Heat Pump, 75°
472	Syon Clinic	5 Brentford	yes	148,000	69	Air Source Heat Pump, 75°
476	Tesco Syon Lane Development	5 Brentford	yes	8,042,638	5521	Air Source Heat Pump, 55°
479	The Musical Museum	5 Brentford	yes	159,000	46	Air Source Heat Pump, 75°

ID	Load Name	Cluster	Included in Complete Borough Network?	Annual Heat Demand (kWh)	Undiversified Peak Heat Demand (kW)	Counterfactual (heating source and flow temperature)
482	Travelodge London Kew Bridge	5 Brentford	yes	1,700,000	715	Air Source Heat Pump, 75°
483	Trimmer Walk Depot	5 Brentford	yes	35,388	16	Air Source Heat Pump, 75°
484	University of West London Brentford Campus	5 Brentford	yes	3,408,000	1770	Air Source Heat Pump, 75°
485	Vantage West	5 Brentford	yes	848,920	395	Air Source Heat Pump, 75°
486	Volkswagen, Capital Interchange Way	5 Brentford	yes	1,544,000	734	Air Source Heat Pump, 75°
487	Wallis House	5 Brentford	yes	1,299,000	909	Gas Boilers, 75°
488	West Cross Industrial Park (existing)	5 Brentford	yes	2,880,000	1370	Air Source Heat Pump, 75°
490	West London Audi	5 Brentford	yes	768,000	365	Air Source Heat Pump, 75°
492	30 Rugby Road (new) Development	6 Isleworth	yes	1,695,435	788	Air Source Heat Pump, 55°
493	Argyle Health Isleworth Practice	6 Isleworth	yes	59,200	28	Air Source Heat Pump, 75°
496	Europa House (new) Development	6 Isleworth	yes	88,976	62	Gas Boilers, 75°
497	Green School for boys	5 Brentford	yes	153,048	87	Air Source Heat Pump, 75°
498	Green School for girls	5 Brentford	yes	753,075	428	Air Source Heat Pump, 75°
499	Gumley House Convent School	6 Isleworth	yes	644,879	367	Air Source Heat Pump, 75°
504	Isleworth Ambulance Station	6 Isleworth	yes	280,000	159	Air Source Heat Pump, 75°
506	Isleworth Leisure Centre & Library	6 Isleworth	yes	774,715	299	Air Source Heat Pump, 75°
507	Isleworth Public Hall	6 Isleworth	yes	94,514	32	Air Source Heat Pump, 75°
508	Isleworth Town Primary School	6 Isleworth	yes	470,694	268	Air Source Heat Pump, 75°
509	Ivy Bridge Retail Park	6 Isleworth	yes	970,000	358	Air Source Heat Pump, 75°
510	Ivybridge Estate (communal)	6 Isleworth	yes	7,243,030	5070	Gas Boilers, 75°
512	Ivybridge Primary School	6 Isleworth	yes	53,190	30	Air Source Heat Pump, 75°
513	Kirstone Lodge	6 Isleworth	yes	522,522	366	Gas Boilers, 75°
514	Langdale Amenity Community Centre	6 Isleworth	yes	9,563	3	Air Source Heat Pump, 75°
516	Marlborough Primary School	5 Brentford	yes	420,134	239	Air Source Heat Pump, 75°
517	Percy Gardens Estate	6 Isleworth	yes	314,900	220	Gas Boilers, 75°
518	Queen Mary Maternity Unit	6 Isleworth	yes	1,607,144	313	Air Source Heat Pump, 75°
519	Redlees Children's Centre	6 Isleworth	yes	54,027	31	Gas Boilers, 75°
521	Saracen House	6 Isleworth	yes	624,800	291	Air Source Heat Pump, 75°
524	South Isleworth Children's Centre	6 Isleworth	yes	69	1	Gas Boilers, 75°
525	St. Johns Centre	6 Isleworth	yes	42,690	20	Air Source Heat Pump, 75°
529	Tesco Isleworth (existing)	6 Isleworth	yes	1,827,000	674	Air Source Heat Pump, 75°
533	Twickenham Stadium	6 Isleworth	yes	2,176,000	894	Air Source Heat Pump, 75°
535	Victory Business Centre (new) Development	6 Isleworth	yes	670,080	319	Air Source Heat Pump, 55°
536	West London Mental Health NHS Trust: MHU	6 Isleworth	yes	282,917	55	Air Source Heat Pump, 75°
537	West London Mental Health NHS Trust: O Block	6 Isleworth	yes	104,554	20	Air Source Heat Pump, 75°
538	West London Mental Health NHS Trust: T Block	6 Isleworth	yes	119,953	23	Air Source Heat Pump, 75°
540	West Middlesex University Hospital: East Wing	6 Isleworth	yes	4,304,308	837	Air Source Heat Pump, 75°
541	West Middlesex University Hospital: Main Block	6 Isleworth	yes	8,416,454	1637	Air Source Heat Pump, 75°

ID	Load Name	Cluster	Included in Complete Borough Network?	Annual Heat Demand (kWh)	Undiversified Peak Heat Demand (kW)	Counterfactual (heating source and flow temperature)
542	West Middlesex University Hospital: Marjory warren building	6 Isleworth	yes	1,032,072	201	Air Source Heat Pump, 75°
552	Wynne Court	6 Isleworth	yes	3,319,458	2324	Gas Boilers, 75°

Table 15-8: Table of all loads included in one or more proposed networks

ID	Load Name	Cluster	Reason for exclusion
4	206-210 Hanworth Road (new) Development	1 Hounslow Town Centre	Pre-planning site allocation post-2025
5	330 Hanworth Road Estate	1 Hounslow Town Centre	Unsuitable for DH connection
6	34 Staines Road Hounslow (existing)	1 Hounslow Town Centre	Demolished or planned for demolishment
8	35 Lampton Road	1 Hounslow Town Centre	Unlikely to connect initially
11	80-82 Staines Road (new) Development	1 Hounslow Town Centre	Pre-planning site allocation post-2025
12	Alexandra Primary School	1 Hounslow Town Centre	Existing/planned LZC
13	Bailey House 40 Bulstrode Road Estate	1 Hounslow Town Centre	Unsuitable for DH connection
15	Brookwood Estate	1 Hounslow Town Centre	Specialist crossing required
17	Chatsworth Primary School	1 Hounslow Town Centre	Existing/planned LZC
18	Civic Centre (Lampton Parkside) Development	1 Hounslow Town Centre	Specialist crossing required
21	Euro House (new) Development	1 Hounslow Town Centre	Pre-planning site allocation post-2025
24	Glenwood Road, James Street & Pears Road Estate	1 Hounslow Town Centre	Unsuitable for DH connection
27	Grove Road Estate	1 Hounslow Town Centre	Unsuitable for DH connection
28	Grove Road Primary School	1 Hounslow Town Centre	Existing/planned LZC
29	Hall Road Estate	1 Hounslow Town Centre	Unsuitable for DH connection
31	Heldmen Close Estate	1 Hounslow Town Centre	Unsuitable for DH connection
34	Hounslow Bus Garage Development	1 Hounslow Town Centre	Pre-planning site allocation post-2025
40	Hounslow Town Primary Residential	1 Hounslow Town Centre	Unlikely to connect initially
43	Inwood Business Park (existing)	1 Hounslow Town Centre	Unsuitable for DH connection
45	Ivy Road Estate	1 Hounslow Town Centre	Too small/low heat density pipe
48	Kingsley Road Youth Centre (new) Development	1 Hounslow Town Centre	Pre-planning site allocation post-2025
49	Lampton House Development	1 Hounslow Town Centre	Specialist crossing required
50	Lampton School	1 Hounslow Town Centre	Specialist crossing required
52	Land at Bridge Road Depot Development	1 Hounslow Town Centre	Pre-planning site allocation post-2025
53	Land at Clarence Terrace Development	1 Hounslow Town Centre	Pre-planning site allocation post-2025
59	Oaklands School	1 Hounslow Town Centre	Existing/planned LZC
60	Park Grand Hotel	1 Hounslow Town Centre	Specialist crossing required
61	Pears Road Estate	1 Hounslow Town Centre	Too small/low heat density pipe
66	Royal Mail Delivery Office (new) Development	1 Hounslow Town Centre	Pre-planning site allocation post-2025
68	Spring Grove Primary School	1 Hounslow Town Centre	Existing/planned LZC
70	Stanborough Road Estate	1 Hounslow Town Centre	Unsuitable for DH connection
74	The Hollies Estate	1 Hounslow Town Centre	Too small/low heat density pipe
80	Upstage Spring Grove Road (existing)	1 Hounslow Town Centre	Demolished or planned for demolishment
81	Upstage Spring Grove Road (new) Development	1 Hounslow Town Centre	Pre-planning site allocation post-2025
82	Wellington Primary School	2 Central and Hounslow West	Existing/planned LZC
83	Whitton Road Estate	1 Hounslow Town Centre	Unsuitable for DH connection
84	Beavers Children's Centre (The Hub)	2 Central and Hounslow West	Existing/planned LZC
86	Beavers Lane Estate	2 Central and Hounslow West	Unsuitable for DH connection
90	Cobbs Road Estate	2 Central and Hounslow West	Unsuitable for DH connection
93	Ede Close Estate	2 Central and Hounslow West	Unsuitable for DH connection
94	Faggs Road Estate	2 Central and Hounslow West	Unsuitable for DH connection
95	Faggs Road Warehouse	4 Feltham	Unsuitable for DH connection
96	Former Morrisons 8 Cavendish Parade	2 Central and Hounslow West	Unlikely to connect initially
98	Hatton Green Estate	2 Central and Hounslow West	Unsuitable for DH connection
101	Heathrow International Trading Estate (existing)	2 Central and Hounslow West	Demolished or planned for demolishment
103	Hilton Garden Inn Heathrow Hatton Cross	2 Central and Hounslow West	Specialist crossing required
107	Hounslow Heath Junior School	2 Central and Hounslow West	Existing/planned LZC
108	Hounslow West Station (new) Development	2 Central and Hounslow West	Pre-planning site allocation post-2025
109	Ivy Lane Estate	2 Central and Hounslow West	Too small/low heat density pipe
110	Land at Airport Business Park Development	4 Feltham	Pre-planning site allocation post-2025
111	Land at Central Park Trading Estate Development	2 Central and Hounslow West	Pre-planning site allocation post-2025
112	Land at Clements Court Development	2 Central and Hounslow West	Existing/planned LZC
113	Land at Dick Turpin Way Development	2 Central and Hounslow West	Pre-planning site allocation post-2025
114	Land at Faggs Road Warehouse Development	4 Feltham	Pre-planning site allocation post-2025
116	Land at Green Lane Development	2 Central and Hounslow West	Pre-planning site allocation post-2025
117	Land at Hounslow Cavalry Barracks Development	2 Central and Hounslow West	Pre-planning site allocation post-2025
118	Land at Ron Smith Recycling Green Lane Development	2 Central and Hounslow West	Pre-planning site allocation post-2025
120	Lela & Legrace Estate	2 Central and Hounslow West	Unsuitable for DH connection
122	Marshall Close Estate	2 Central and Hounslow West	Unsuitable for DH connection
123	Martingdale Estate	2 Central and Hounslow West	Unsuitable for DH connection
126	Orchard Primary School	2 Central and Hounslow West	Existing/planned LZC
127	St Aubyn’s Estate	2 Central and Hounslow West	Unsuitable for DH connection
128	St. Michael & St Martin Primary School	2 Central and Hounslow West	Existing/planned LZC

ID	Load Name	Cluster	Reason for exclusion
129	Sutton Lane Estate	2 Central and Hounslow West	Unsuitable for DH connection
131	Tesco Dukes Green Avenue (existing)	4 Feltham	Demolished or planned for demolishment
138	Trafalgar Court Estate	2 Central and Hounslow West	Unsuitable for DH connection
140	150-152 Great South West Road Development	2 Central and Hounslow West	Pre-planning site allocation post-2025
142	Armytage Road Estate	3 Cranford and Heston West	Unsuitable for DH connection
143	Aston Green & Rectory Road Estate	3 Cranford and Heston West	Unsuitable for DH connection
144	Beech House Estate	3 Cranford and Heston West	Too small/low heat density pipe
145	Beechcroft Close Estate	3 Cranford and Heston West	Too small/low heat density pipe
147	Blackthorn Court Estate	3 Cranford and Heston West	Too small/low heat density pipe
148	Brabazon Road Estate	3 Cranford and Heston West	Unsuitable for DH connection
149	Cole Garden Estate	3 Cranford and Heston West	Too small/low heat density pipe
151	Convent Way Estate (new) Development	3 Cranford and Heston West	Pre-planning site allocation post-2025
153	Cranford Library	3 Cranford and Heston West	Existing/planned LZC
154	Cranford Primary School	3 Cranford and Heston West	Existing/planned LZC
156	Ditton Road Estate	3 Cranford and Heston West	Unsuitable for DH connection
160	Heston Farm Estate	3 Cranford and Heston West	Too small/low heat density pipe
161	Heston Library	3 Cranford and Heston West	Existing/planned LZC
162	Heston Pools	3 Cranford and Heston West	Existing/planned LZC
163	Heston Primary School	3 Cranford and Heston West	Too small/low heat density pipe
164	Heston Village Hall	3 Cranford and Heston West	Too small/low heat density pipe
166	Hounslow West Depot 75 Great South west Road	2 Central and Hounslow West	Too small/low heat density pipe
167	Land South of Western International Market Development	3 Cranford and Heston West	Pre-planning site allocation post-2025
168	Lovat Walk Estate	3 Cranford and Heston West	Too small/low heat density pipe
172	North Hyde Lane & Rostrevor Gardens Estate	3 Cranford and Heston West	Unsuitable for DH connection
173	Northfield Road Estate	3 Cranford and Heston West	Unsuitable for DH connection
174	Norwood Green Infant + Junior School	3 Cranford and Heston West	Too small/low heat density pipe
175	Nursery on the Green	3 Cranford and Heston West	Too small/low heat density pipe
177	Rectory Court	3 Cranford and Heston West	Too small/low heat density pipe
180	Springwell Junior School	3 Cranford and Heston West	Too small/low heat density pipe
181	The Cedars Primary School	3 Cranford and Heston West	Existing/planned LZC
183	Thorncliffe Road Estate	3 Cranford and Heston West	Too small/low heat density pipe
184	Travelodge Heathrow Heston M4 Eastbound	3 Cranford and Heston West	Specialist crossing required
187	Vicarage Farm Nursing Home	3 Cranford and Heston West	Too small/low heat density pipe
188	2 High Street (new) Development	4 Feltham	Pre-planning site allocation post-2025
192	80-86 High Street Feltham (new) Development	4 Feltham	Pre-planning site allocation post-2025
193	Airman Parade Estate	4 Feltham	Too small/low heat density pipe
194	Allied Estate	4 Feltham	Unsuitable for DH connection

ID	Load Name	Cluster	Reason for exclusion
196	Attlee House Estate	4 Feltham	Too small/low heat density pipe
197	Bear Road	4 Feltham	Specialist crossing required
198	Bedfont Lakes (Grange Hotel) Development	4 Feltham	Too small/low heat density pipe
199	Bedfont Lane Estate	4 Feltham	Unsuitable for DH connection
200	Bedfont Primary School	4 Feltham	Too small/low heat density pipe
202	Bedfont Library	4 Feltham	Existing/planned LZC
204	Bethany Way Estate	4 Feltham	Unsuitable for DH connection
205	Bevan House Estate	4 Feltham	Too small/low heat density pipe
207	Browells Lane (new) Development	4 Feltham	Pre-planning site allocation post-2025
208	Burlington Close Estate	4 Feltham	Too small/low heat density pipe
209	Cambria Court Estate	4 Feltham	Too small/low heat density pipe
211	Chestnut Court Estate	4 Feltham	Too small/low heat density pipe
213	Council Depot, Ashmead Road (new) Development	4 Feltham	Pre-planning site allocation post-2025
214	Crane Park Primary School	4 Feltham	Too small/low heat density pipe
216	Dickenson Road Estate	4 Feltham	Unsuitable for DH connection
217	Eastbourne Road Estate	4 Feltham	Unsuitable for DH connection
219	Edward Pauling School	4 Feltham	Existing/planned LZC
220	Elmwood Avenue Estate	4 Feltham	Too small/low heat density pipe
221	Engleheart Drive & Pentelow Gardens Estate	4 Feltham	Unsuitable for DH connection
223	Feltham Assembly Hall	4 Feltham	Existing/planned LZC
225	Feltham Coachworks (new) Development	1 Hounslow Town Centre	Pre-planning site allocation post-2025
233	Feltham Lodge Estate/Becketts Close	4 Feltham	Unsuitable for DH connection
234	Feltham Lodge Register Office	4 Feltham	Existing/planned LZC
238	Field Road Estate	4 Feltham	Too small/low heat density pipe
239	Florence Road Estate	4 Feltham	Too small/low heat density pipe
240	Frank Towell Court	4 Feltham	Existing/planned LZC
241	Hampton Road East Estate	4 Feltham	Too small/low heat density pipe
242	Hampton Road West Estate	4 Feltham	Too small/low heat density pipe
246	Hatchett Road Estate	4 Feltham	Unsuitable for DH connection
247	Hatton Road Estate	4 Feltham	Unsuitable for DH connection
248	High Street Feltham Estate	4 Feltham	Too small/low heat density pipe
251	Hounslow Road, Ridge Way & Windslow Road Estate	4 Feltham	Unsuitable for DH connection
252	Hounslow School Library Services	4 Feltham	Too small/low heat density pipe
254	Land at Bedfont Gardens Development 1	4 Feltham	Pre-planning site allocation post-2025
256	Land at Frank Towell Court Development	4 Feltham	Existing/planned LZC
258	Land at Raleigh Park Lower Feltham West Development	4 Feltham	Pre-planning site allocation post-2025
259	Land at South Bedfont Development	4 Feltham	Pre-planning site allocation post-2025

ID	Load Name	Cluster	Reason for exclusion
260	Land at Southville Crescent, Bedfont Gardens Development 2	4 Feltham	Pre-planning site allocation post-2025
261	Land to South Bedfont Road Development	4 Feltham	Too small/low heat density pipe
264	Leisure West (new) Development	4 Feltham	Pre-planning site allocation post-2025
266	Lidl Feltham (new) Development	4 Feltham	Pre-planning site allocation post-2025
269	Lower Bedfont Estate	4 Feltham	Unsuitable for DH connection
270	Main Street Estate	4 Feltham	Too small/low heat density pipe
272	Manor Park (new) Development	4 Feltham	Pre-planning site allocation post-2025
273	Manor Place (Formerly New Road Car Park & Feltham Labour Club)	4 Feltham	Unlikely to connect initially
274	Maple Industrial Estate	4 Feltham	Too small/low heat density pipe
275	Marjory Kinnon School	4 Feltham	Too small/low heat density pipe
277	MOD Feltham (new) Development	4 Feltham	Pre-planning site allocation post-2025
280	New Close Estate	4 Feltham	Unsuitable for DH connection
281	New Road Estate	4 Feltham	Unsuitable for DH connection
287	Oxford Way Estate	4 Feltham	Unsuitable for DH connection
289	Poorsland & Poets Estate	4 Feltham	Unsuitable for DH connection
293	Ryland Close Estate	4 Feltham	Unsuitable for DH connection
296	Scout Hut Bedfont Lane (new) Development	4 Feltham	Pre-planning site allocation post-2025
298	Smith House, Elmwood Avenue (existing)	4 Feltham	Demolished or planned for demolishment
300	South Bedfont Estate	4 Feltham	Unsuitable for DH connection
301	South Road Area	4 Feltham	Unsuitable for DH connection
304	Sparrow Farm Estate	4 Feltham	Unsuitable for DH connection
306	Spring Road Estate	4 Feltham	Too small/low heat density pipe
308	St Mary's Estate	4 Feltham	Unsuitable for DH connection
309	St. Catherine's Court Estate	4 Feltham	Too small/low heat density pipe
313	St. Richards Church of England Primary School	4 Feltham	Too small/low heat density pipe
314	Staines Road Estate	4 Feltham	Too small/low heat density pipe
317	Swan Road Estate	4 Feltham	Unsuitable for DH connection
318	Tesco Feltham - 98 High Street (existing)	4 Feltham	Demolished or planned for demolishment
320	The Clumps Estate	4 Feltham	Too small/low heat density pipe
321	The Dell Estate	4 Feltham	Too small/low heat density pipe
324	Turpin Road Estate	4 Feltham	Too small/low heat density pipe
325	Tynan Close Estate	4 Feltham	Too small/low heat density pipe
327	UPS House (new) Development	4 Feltham	Pre-planning site allocation post-2025
330	Viola Estate	4 Feltham	Unsuitable for DH connection
336	Wilson House Estate	4 Feltham	Too small/low heat density pipe
338	1020 Great West Road & Adjacent Site Opposite Windmill Road (new) Development	5 Brentford	Pre-planning site allocation post-2025

ID	Load Name	Cluster	Reason for exclusion
339	110 Power Road	5 Brentford	Unsuitable for DH connection
341	125 Harlequin Avenue (new) Development	5 Brentford	Pre-planning site allocation post-2025
343	2 Harlequin Avenue (new) Development	5 Brentford	Pre-planning site allocation post-2025
344	27 & 1053 Great West Road Development	5 Brentford	Pre-planning site allocation post-2025
346	69 to 77 Boston Manor Road (new) Development	5 Brentford	Pre-planning site allocation post-2025
347	931 Great West Road - Skoda (existing)	5 Brentford	Demolished or planned for demolishment
350	971 Great West Road (new) Development	5 Brentford	Pre-planning site allocation post-2025
351	Acton Lodge Resource Centre - Brentford Care Centre	5 Brentford	Demolished or planned for demolishment
354	Belmont Primary School	5 Brentford	Existing/planned LZC
355	Berkeley House Estate	5 Brentford	Unsuitable for DH connection
357	Boston Manor Road Estate	5 Brentford	Too small/low heat density pipe
358	Brent Lea (individual boiler)	5 Brentford	Unsuitable for DH connection
360	Brentford Block D	5 Brentford	Existing/planned LZC
366	Brentford FC Offices	5 Brentford	Pre-planning site allocation post-2025
367	Brentford Fountains Leisure Centre (existing)	5 Brentford	Demolished or planned for demolishment
369	Brentford Group Practice (existing)	5 Brentford	Demolished or planned for demolishment
375	Brentside Park (existing)	5 Brentford	Demolished or planned for demolishment
377	BSS Brentford (existing)	5 Brentford	Specialist crossing required
378	BSS Brentford (new) Development	5 Brentford	Pre-planning site allocation post-2025
379	Burden Close Estate	5 Brentford	Too small/low heat density pipe
380	Burford House Estate	5 Brentford	Too small/low heat density pipe
381	Carfax Court Estate	5 Brentford	Too small/low heat density pipe
382	Cedar Court Estate	5 Brentford	Too small/low heat density pipe
383	Charlton House and Albany House Estate	5 Brentford	Demolished or planned for demolishment
384	Cherry Tree House Estate	5 Brentford	Too small/low heat density pipe
385	Claypонds Estate	5 Brentford	Unsuitable for DH connection
386	Clifden Court Estate	5 Brentford	Too small/low heat density pipe
387	Clitherow Court Estate	5 Brentford	Too small/low heat density pipe
388	Clitherow Road Estate	5 Brentford	Unsuitable for DH connection
389	County Parade Estate	5 Brentford	Too small/low heat density pipe
390	Ealing Road Estate	5 Brentford	Unsuitable for DH connection
392	EMC Tower (new) development	5 Brentford	Pre-planning site allocation post-2025
393	Epworth Road Estate	5 Brentford	Unsuitable for DH connection
399	Former NatWest Bank Site, Chiswick Curve Development	5 Brentford	Pre-planning site allocation post-2025
401	Gillette Building Studios (new) Development	5 Brentford	Pre-planning site allocation post-2025

ID	Load Name	Cluster	Reason for exclusion
404	Great West Plaza (existing)	5 Brentford	Unlikely to connect initially
405	Great West Plaza (new) Development	5 Brentford	Pre-planning site allocation post-2025
407	Green Dragon Lane Estate - Haverfield (individual boiler)	5 Brentford	Unsuitable for DH connection
408	Green dragon Primary School	5 Brentford	Existing/planned LZC
412	Gunnersbury Catholic School for Boys	5 Brentford	Existing/planned LZC
413	Harlequin Avenue Sub-Station (new) Development	5 Brentford	Pre-planning site allocation post-2025
414	High Street Brentford Estate	5 Brentford	Too small/low heat density pipe
421	Land at 110 Power Road Development	5 Brentford	Pre-planning site allocation post-2025
422	Land at Boston Manor Road Sub Station Development	5 Brentford	Pre-planning site allocation post-2025
423	Land at Enterprise, Boston Park Road Development	5 Brentford	Pre-planning site allocation post-2025
424	Land at Esso Filling Station Chiswick Roundabout Development	5 Brentford	Pre-planning site allocation post-2025
425	Land at Former Syon gate Service Station Gillette Corner Development	5 Brentford	Pre-planning site allocation post-2025
426	Land at GlaxoSmithKline Development	5 Brentford	Pre-planning site allocation post-2025
427	Land at Great West house Development	5 Brentford	Pre-planning site allocation post-2025
428	Land at Gunnersbury Station Car Park Development	5 Brentford	Pre-planning site allocation post-2025
429	Land at Layton Road Car Park Development	5 Brentford	Pre-planning site allocation post-2025
430	Land at Profile West Development	5 Brentford	Pre-planning site allocation post-2025
431	Land at Texaco Filling Station, Great West Road Development	5 Brentford	Pre-planning site allocation post-2025
432	Land at Vantage West Development	5 Brentford	Pre-planning site allocation post-2025
433	Lateward Road Estate	5 Brentford	Too small/low heat density pipe
434	Layton Road Area Estate	5 Brentford	Too small/low heat density pipe
436	Lionel Road Estate	5 Brentford	Unsuitable for DH connection
437	Lionel Road Primary school	5 Brentford	Too small/low heat density pipe
438	Lodge Close Estate	5 Brentford	Too small/low heat density pipe
441	Meade Close Estate	5 Brentford	Too small/low heat density pipe
442	Meadowcroft Estate	5 Brentford	Too small/low heat density pipe
443	Mercury House Estate	5 Brentford	Too small/low heat density pipe
445	Mille Building (new) Development	5 Brentford	Pre-planning site allocation post-2025
447	Myers Court (Reynard Mills)	5 Brentford	Unlikely to connect initially
449	Osterley Library	1 Hounslow Town Centre	Existing/planned LZC
450	Osterley Sports & Athletics Centre	1 Hounslow Town Centre	Existing/planned LZC
451	Our Lady & St. John Rc J	5 Brentford	Existing/planned LZC
452	Oxford Court Estate	5 Brentford	Too small/low heat density pipe
453	Oxford Road South Estate	5 Brentford	Too small/low heat density pipe
456	Phoenix Business Park (existing)	5 Brentford	Unsuitable for DH connection
457	Phoenix Business Park (new) Development	5 Brentford	Pre-planning site allocation post-2025
458	Pinkham Mansions Estate	5 Brentford	Too small/low heat density pipe
461	Profile West	5 Brentford	Specialist crossing required
463	Robin Grove, Willow Close & Brentside Estate	5 Brentford	Unsuitable for DH connection
464	Sidney Gardens Estate	5 Brentford	Too small/low heat density pipe
467	Somerset Lodge Estate	5 Brentford	Too small/low heat density pipe
468	St Paul's House Estate	5 Brentford	Too small/low heat density pipe
470	Strand-on-the-Green Estate	5 Brentford	Too small/low heat density pipe
471	Strand-on-the-green junior	5 Brentford	Too small/low heat density pipe
473	Syon Estate	5 Brentford	Unsuitable for DH connection
474	Syon Lane Industrial Estate (existing)	5 Brentford	Unsuitable for DH connection
475	Syon Lane Industrial Estate (new) Development	5 Brentford	Pre-planning site allocation post-2025
477	The Mall Estate	5 Brentford	Too small/low heat density pipe
478	The Maltings Estate	5 Brentford	Specialist crossing required
480	The Ride Children's Home	5 Brentford	Too small/low heat density pipe
481	Tomlinson Close Estate	5 Brentford	Too small/low heat density pipe
489	West Cross Industrial Park (new) Development	5 Brentford	Pre-planning site allocation post-2025
491	30 Rugby Road (existing) - Access Self Storage	6 Isleworth	Demolished or planned for demolishment
494	Beechen Cliff Estate	6 Isleworth	Unsuitable for DH connection
495	Europa House (existing)	6 Isleworth	Demolished or planned for demolishment
500	Harcourt Close Estate	6 Isleworth	Unsuitable for DH connection
501	Hartland Road Estate	6 Isleworth	Too small/low heat density pipe
511	Ivybridge Estate (individual boiler)	6 Isleworth	Unsuitable for DH connection
515	London Square Isleworth 396-418 London Road	6 Isleworth	Unlikely to connect initially
520	Richmond Estate	6 Isleworth	Unsuitable for DH connection
522	Smallberry Green School	5 Brentford	Existing/planned LZC
523	Snowy Fielder Waye Estate	6 Isleworth	Unsuitable for DH connection
526	St. Mary's Catholic Primary School	6 Isleworth	Existing/planned LZC
527	Swan Court And White Lion Court	6 Isleworth	Unlikely to connect initially
528	Swann and Wisdom Estate	6 Isleworth	Too small/low heat density pipe
530	Tesco Isleworth (new) Development	6 Isleworth	Pre-planning site allocation post-2025
531	The Blue CE Primary School	6 Isleworth	Existing/planned LZC
532	Twickenham Road 116 Estate	6 Isleworth	Too small/low heat density pipe
534	Victory Business Centre (existing)	6 Isleworth	Unsuitable for DH connection
539	West Middlesex Hospital (new) Development	6 Isleworth	Pre-planning site allocation post-2025
546	Woodbridge Park education Centre	1 Hounslow Town Centre	Existing/planned LZC
547	Woodlands Road Estate	6 Isleworth	Too small/low heat density pipe
548	Worple Estate	6 Isleworth	Unsuitable for DH connection

ID	Load Name	Cluster	Reason for exclusion
549	Worple Primary School	6 Isleworth	Existing/planned LZC
550	Worton Estate	6 Isleworth	Unsuitable for DH connection
551	Worton Road Estate	6 Isleworth	Unsuitable for DH connection

Table 15-9: Table of excluded loads

Appendix F – Identified Electrical & Cooling Loads

Both cooling and electrical loads have been collected, benchmarked where possible and mapped, however due to the limited carbon benefit of serving these via district energy, cooling and electrical private wire networks have been excluded from this study.

Cooling in the Borough is currently served by electrically fed chillers or heat pumps (DX or VRF). Existing cooling systems are likely to already achieve a good Seasonable Coefficient of Performance (SCoP). A district cooling network may achieve a higher SCoP i.e. more efficient than existing cooling systems by using industrial, specialist generation plant, however distribution losses from the cooling network would reduce this benefit somewhat. The carbon savings offered by district cooling therefore is the difference between the efficiencies of both systems, as both use electricity as the main fuel. The carbon intensity of grid electricity is projected to decrease significantly in the first 10 years of the proposed network (see Figure 15-4: Carbon Intensity in the Balance Net Zero Carbon Pathway source: BEIS (2020)) meaning that the difference in efficiency between existing cooling systems and a proposed district cooling network would translate to minor carbon savings. If we also consider the embodied carbon of district cooling infrastructure and loss of existing plant life, this further reduces the benefit. District cooling would be significantly less effective use of resource and capital in terms of carbon savings than district heating, which typically replaces natural gas combustion.

Localised electricity generation is critical to reduce demand on the electricity grid and the development of renewable electricity generation within the study boundary is encouraged. To provide carbon benefit over, localised generation at a building level, or a decarbonised electricity grid, a private wire network would need to be supplied by a large source of renewable generation e.g., a large PV array. No such scale or reliability of opportunity was identified within the study boundary. Mogden STW currently contains a biogas CHP which generates low/zero carbon electricity; however Thames Waters plans for this are not confirmed and there is potential that it does not get replaced at the imminent end of life. If replaced, and even upgraded this could be a suitable source of generation for a private wire feeding a local network, or potentially preferably, a local electric heat pump fuelled energy centre.

At the end of the heat mapping and masterplanning phase of this project Greater London Authority issued a major warning to developers that all new major grid connections in West London would be delayed by a decade plus to enable necessary grid reinforcements. This is a key risk for a Hounslow heat network since the network heat is predominantly electrically driven. This should be investigated in future design stages.

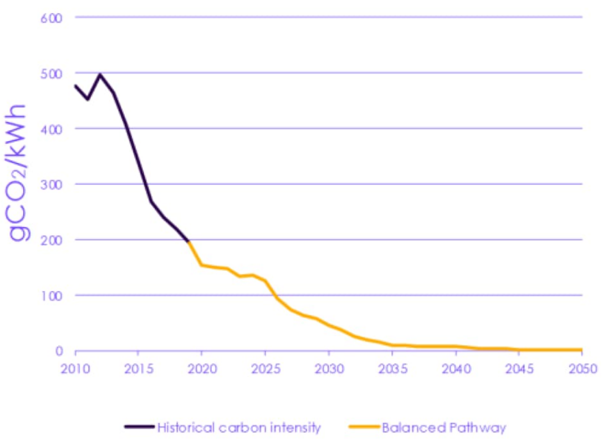


Figure 15-4: Carbon Intensity in the Balance Net Zero Carbon Pathway source: BEIS (2020)

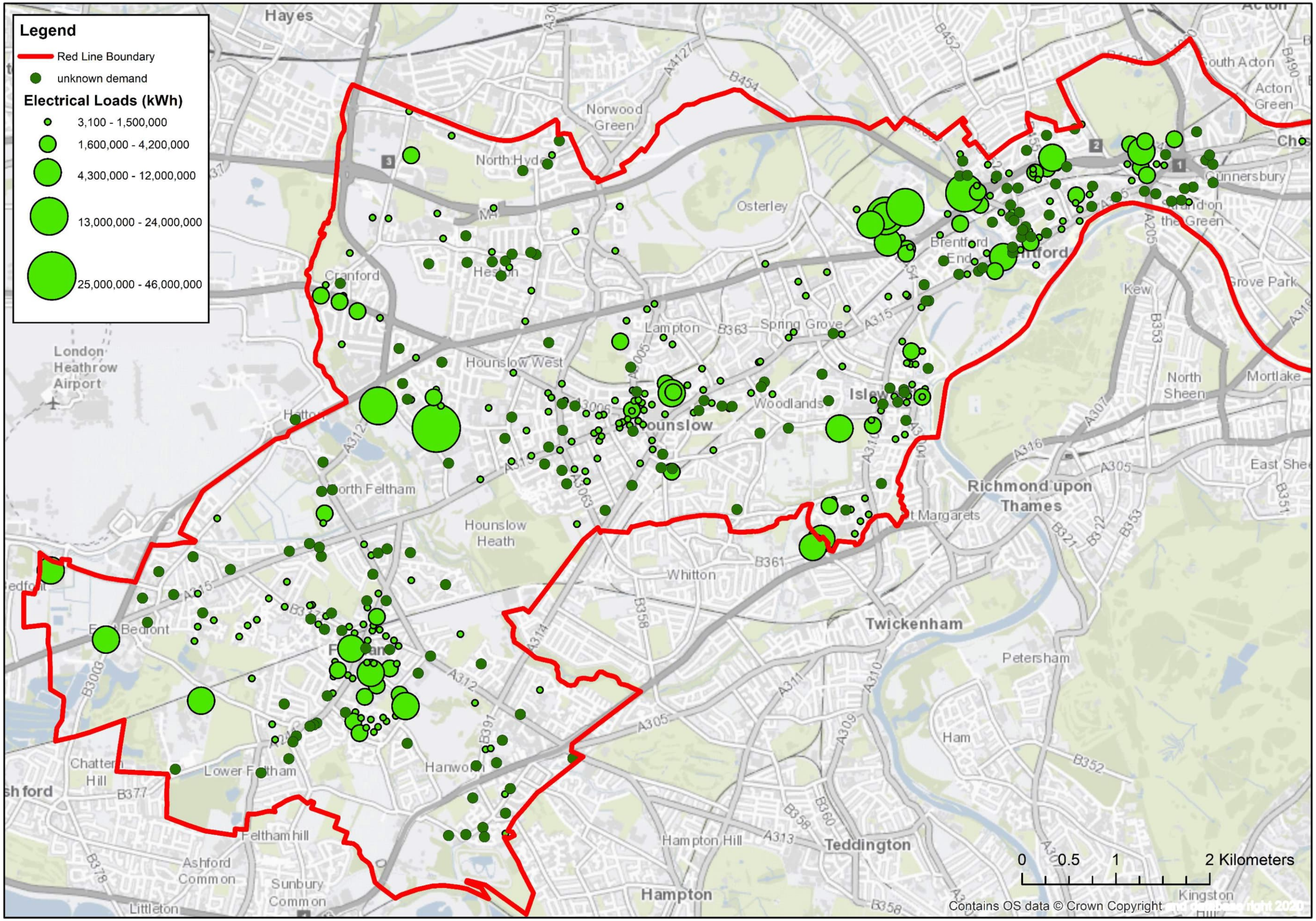


Figure 15-5: Electricity demand bubble map.

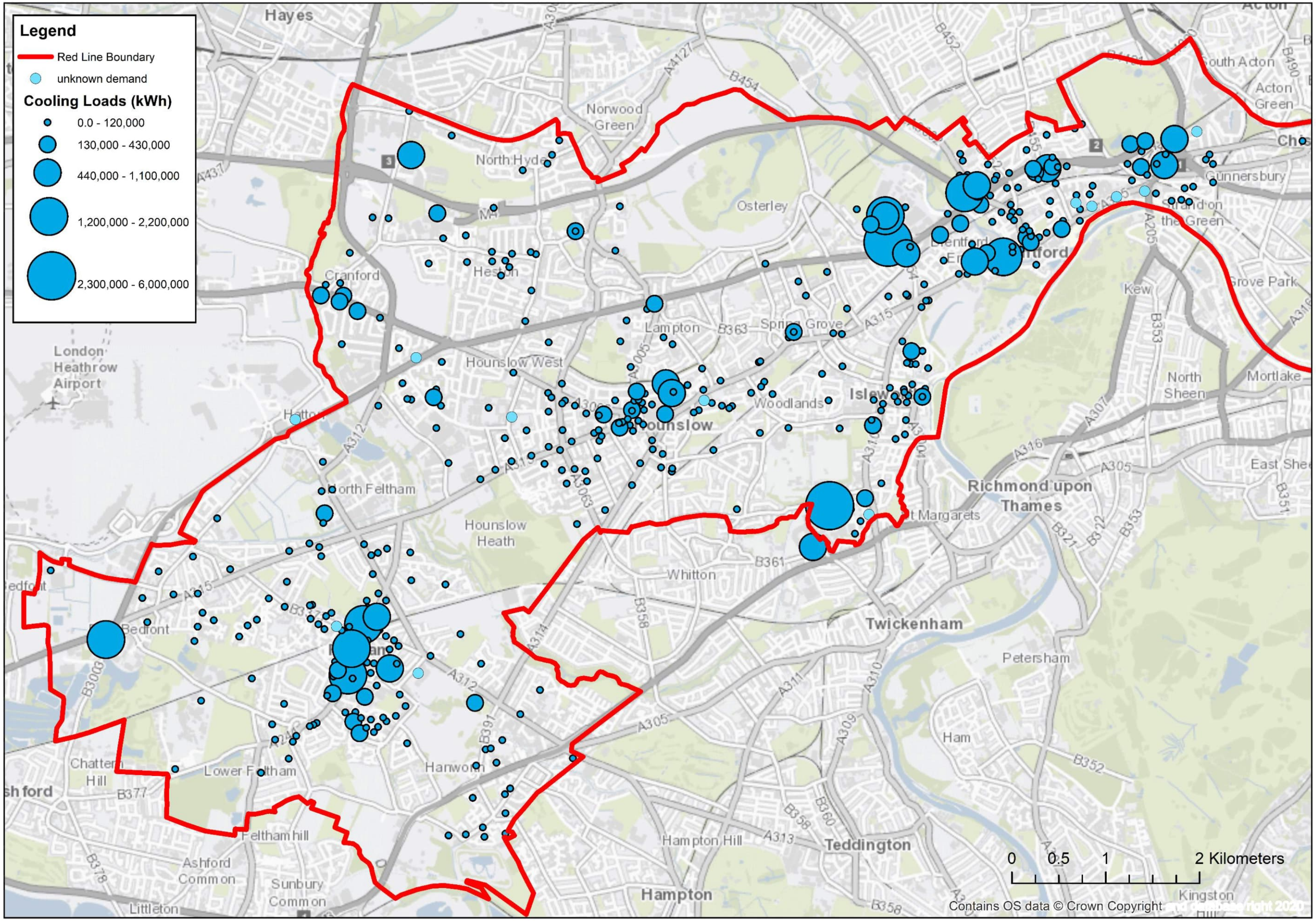


Figure 15-6: Cooling demand bubble map.

Appendix G – Excluded Loads Data Quality

Several loads identified did not have metered or DEC/EPC demand data. For those that were removed from consideration prior to benchmarking for qualitative reasons such as unsuitability to connect to district heating (i.e. not related to magnitude of demand), estimates of floor areas were not made and therefore annual demands were not calculated through floor area-based benchmarking. These loads have been mapped throughout, however; the magnitude of demand not represented. These loads are captured in Table 15-10. For some loads metered heat demand data was provided however no floor area was provided meaning benchmarked based electricity and cooling demands could not be calculated, these have also been captured in Table 15-10.

ID	Load Name	Cluster	Northing	Easting
5	330 Hanworth Road Estate	1 Hounslow Town Centre	513498	174871
8	35 Lampton Road	1 Hounslow Town Centre	513548	175869
24	Glenwood Road, James Street & Pears Road Estate	1 Hounslow Town Centre	514564	175713
26	Greenham House	1 Hounslow Town Centre	514907	175972
27	Grove Road Estate	1 Hounslow Town Centre	513508	175448
29	Hall Road Estate	1 Hounslow Town Centre	514615	174615
31	Heldmen Close Estate	1 Hounslow Town Centre	514860	175428
41	Hyde House Estate	1 Hounslow Town Centre	514456	175717
43	Inwood Business Park (existing)	1 Hounslow Town Centre	513922	175016
45	Ivy Road Estate	1 Hounslow Town Centre	513927	175049
58	Number 10 Project School Road Centre	1 Hounslow Town Centre	514265	175775
61	Pears Road Estate	1 Hounslow Town Centre	514209	175669
70	Stanborough Road Estate	1 Hounslow Town Centre	514873	175920
74	The Hollies Estate	1 Hounslow Town Centre	513484	176131
78	Triangle Day Centre	1 Hounslow Town Centre	513824	175204
83	Whitton Road Estate	1 Hounslow Town Centre	513808	175059
86	Beavers Lane Estate	2 Central and Hounslow West	511103	175790
90	Cobbs Road Estate	2 Central and Hounslow West	512751	175031
93	Ede Close Estate	2 Central and Hounslow West	512753	175741
94	Faggs Road Estate	2 Central and Hounslow West	510304	174823
95	Faggs Road Warehouse	4 Feltham	510190	174807
97	George Chatt House	2 Central and Hounslow West	511053	175957
98	Hatton Green Estate	2 Central and Hounslow West	510205	175119
103	Hilton Garden Inn Heathrow Hatton Cross	2 Central and Hounslow West	509909	175572
105	Hounslow Education Centre	2 Central and Hounslow West	512216	175599
109	Ivy Lane Estate	2 Central and Hounslow West	512609	175280
112	Land at Clements Court Development	2 Central and Hounslow West	511543	175108
120	Lela & Legrace Estate	2 Central and Hounslow West	511471	176184
122	Marshall Close Estate	2 Central and Hounslow West	512802	174888
123	Martingdale Estate	2 Central and Hounslow West	512143	175372
124	Midsummer Avenue Estate	2 Central and Hounslow West	512565	175098
125	Old Farm Close Estate	2 Central and Hounslow West	512758	175458
127	St Aubyn's Estate	2 Central and Hounslow West	513211	174606
129	Sutton Lane Estate	2 Central and Hounslow West	512609	176392
138	Trafalgar Court Estate	2 Central and Hounslow West	512890	175718
142	Armytage Road Estate	3 Cranford and Heston West	511739	177247
143	Aston Green & Rectory Road Estate	3 Cranford and Heston West	511015	176330
144	Beech House Estate	3 Cranford and Heston West	512148	177262
145	Beechcroft Close Estate	3 Cranford and Heston West	512008	177254
147	Blackthorn Court Estate	3 Cranford and Heston West	512103	177104
148	Brabazon Road Estate	3 Cranford and Heston West	511331	177232
149	Cole Garden Estate	3 Cranford and Heston West	510388	177024
156	Ditton Road Estate	3 Cranford and Heston West	512722	178543
168	Lovat Walk Estate	3 Cranford and Heston West	512219	177336
172	North Hyde Lane & Rostrevor Gardens Estate	3 Cranford and Heston West	512333	178226
173	Northfield Road Estate	3 Cranford and Heston West	511726	177531
177	Rectory Court	3 Cranford and Heston West	512475	177331
178	Redwood Estate	3 Cranford and Heston West	512419	177353
183	Thorncliffe Road Estate	3 Cranford and Heston West	512596	178296
193	Airman Parade Estate	4 Feltham	511351	173053
194	Allied Estate	4 Feltham	509791	172542
196	Attlee House Estate	4 Feltham	510139	172338
199	Bedfont Lane Estate	4 Feltham	510073	173448
204	Bethany Way Estate	4 Feltham	509217	173975
205	Bevan House Estate	4 Feltham	510105	172318
208	Burlington Close Estate	4 Feltham	508613	173707
209	Cambria Court Estate	4 Feltham	510877	173643
211	Chestnut Court Estate	4 Feltham	511726	171150
215	CRC Bedfont Office	4 Feltham	510349	173369
216	Dickenson Road Estate	4 Feltham	511543	171140
217	Eastbourne Road Estate	4 Feltham	511890	172969
220	Elmwood Avenue Estate	4 Feltham	511102	172121
221	Engleheart Drive & Pentelow Gardens Estate	4 Feltham	510061	174250
226	Feltham Community College	4 Feltham	511218	172870
233	Feltham Lodge Estate/Becketts Close	4 Feltham	510790	174150
238	Field Road Estate	4 Feltham	510888	174195
239	Florence Road Estate	4 Feltham	510915	173122
240	Frank Towell Court	4 Feltham	510295	173510
241	Hampton Road East Estate	4 Feltham	512868	171962

ID	Load Name	Cluster	Northing	Easting
242	Hampton Road West Estate	4 Feltham	512307	172432
246	Hatchett Road Estate	4 Feltham	508334	173412
247	Hatton Road Estate	4 Feltham	508454	173952
248	High Street Feltham Estate	4 Feltham	509921	172201
251	Hounslow Road, Ridge Way & Windslow Road Estate	4 Feltham	512116	172155
269	Lower Bedfont Estate	4 Feltham	509544	171808
270	Main Street Estate	4 Feltham	511908	171226
274	Maple Industrial Estate	4 Feltham	510443	172451
279	New Chapel Square Estate	4 Feltham	510661	173136
280	New Close Estate	4 Feltham	512149	171378
281	New Road Estate	4 Feltham	508820	174110
282	Nursery Close Estate	4 Feltham	510671	173641
285	Oriel Estate (blocks)	4 Feltham	512054	171915
287	Oxford Way Estate	4 Feltham	511801	171541
289	Poorsland & Poets Estate	4 Feltham	510186	174114
291	Rose Gardens & Manor Lane Estate	4 Feltham	510250	172628
293	Ryland Close Estate	4 Feltham	509840	171958
300	South Bedfont Estate	4 Feltham	508922	173513
301	South Road Area	4 Feltham	511925	171126
304	Sparrow Farm Estate	4 Feltham	511510	173814
306	Spring Road Estate	4 Feltham	509884	172138
308	St Mary's Estate	4 Feltham	508281	173669
314	Staines Road Estate	4 Feltham	510165	174211
317	Swan Road Estate	4 Feltham	512200	171640
318	Tesco Feltham - 98 High Street (existing)	4 Feltham	510364	172901
320	The Clumps Estate	4 Feltham	508630	171847
321	The Dell Estate	4 Feltham	510736	173924
322	The Hollands Estate	4 Feltham	511837	171884
324	Turpin Road Estate	4 Feltham	509846	174170
325	Tynan Close Estate	4 Feltham	510405	173325
330	Viola Estate	4 Feltham	511135	174154
332	Waterloo Estate	4 Feltham	510220	173338
336	Wilson House Estate	4 Feltham	510065	172304
339	110 Power Road	5 Brentford	519514	178639
351	Acton Lodge Resource Centre - Brentford Care Centre	5 Brentford	516980	177121
355	Berkeley House Estate	5 Brentford	517915	177559
357	Boston Manor Road Estate	5 Brentford	516988	178169
358	Brent Lea (individual boiler)	5 Brentford	517190	177153
359	Brent Lea and Danehurst (communal)	5 Brentford	517234	177190
362	Brentford Day Nursery (Half Acre)	5 Brentford	517647	177517
366	Brentford FC Offices	5 Brentford	518777	178293
374	Brentford School for Girls	5 Brentford	517692	177626
379	Burden Close Estate	5 Brentford	517382	178166
380	Burford House Estate	5 Brentford	518011	178084
381	Carfax Court Estate	5 Brentford	519612	178338
382	Cedar Court Estate	5 Brentford	517527	177731
385	Clayponds Estate	5 Brentford	517915	178601
386	Clifden Court Estate	5 Brentford	517626	177781
387	Clitherow Court Estate	5 Brentford	517071	178175
388	Clitherow Road Estate	5 Brentford	517021	178327
389	County Parade Estate	5 Brentford	517553	177350
390	Ealing Road Estate	5 Brentford	517701	178441
393	Epworth Road Estate	5 Brentford	516610	177010
394	Fenn House Lodge	5 Brentford	516658	176838
404	Great West Plaza (existing)	5 Brentford	517158	177749
406	Green Dragon Lane Estate - Brentford Towers and Harnage House (communal)	5 Brentford	518405	178060
414	High Street Brentford Estate	5 Brentford	517552	177410
418	Kew Bridge Road and Thameside Centre	5 Brentford	518958	178005
420	Lambert Lodge	5 Brentford	517610	178040
433	Lateward Road Estate	5 Brentford	517944	177753
434	Layton Road Area Estate	5 Brentford	517610	178040
436	Lionel Road Estate	5 Brentford	518214	178670
438	Lodge Close Estate	5 Brentford	516630	176836
441	Meade Close Estate	5 Brentford	519350	177911
442	Meadowcroft Estate	5 Brentford	519476	178050
443	Mercury House Estate	5 Brentford	517493	178036
452	Oxford Court Estate	5 Brentford	519687	178291
453	Oxford Road South Estate	5 Brentford	519689	178096
456	Phoenix Business Park (existing)	5 Brentford		
458	Pinkham Mansions Estate	5 Brentford	519385	178034
463	Robin Grove, Willow Close & Brentside Estate	5 Brentford	517336	177676
464	Sidney Gardens Estate	5 Brentford	517533	177859
467	Somerset Lodge Estate	5 Brentford	517567	177693
468	St Paul's House Estate	5 Brentford	517747	177522
470	Strand-on-the-Green Estate	5 Brentford	519246	177899
473	Syon Estate	5 Brentford	516818	177263

ID	Load Name	Cluster	Northing	Easting
474	Syon Lane Industrial Estate (existing)	5 Brentford	516550	177367
477	The Mall Estate	5 Brentford	517658	177593
478	The Maltings Estate	5 Brentford	519079	177978
479	The Musical Museum	5 Brentford	518659	177944
481	Tomlinson Close Estate	5 Brentford	519651	178393
482	Travelodge London Kew Bridge	5 Brentford	518396	177843
486	Volkswagen, Capital Interchange Way	5 Brentford	519183	178396
487	Wallis House	5 Brentford	518129	178267
491	30 Rugby Road (existing) - Access Self Storage	6 Isleworth	515516	174300
494	Beechen Cliff Estate	6 Isleworth	515642	176490
495	Europa House (existing)	6 Isleworth	516621	175897
500	Harcourt Close Estate	6 Isleworth	516245	175908
501	Hartland Road Estate	6 Isleworth	516394	175892
511	Ivybridge Estate (individual boiler)	6 Isleworth	515776	174608
520	Richmond Estate	6 Isleworth	516416	175564
523	Snowy Fielder Waye Estate	6 Isleworth	516652	176118
528	Swann and Wisdom Estate	6 Isleworth	516329	175760
532	Twickenham Road 116 Estate	6 Isleworth	516171	175737
534	Victory Business Centre (existing)	6 Isleworth	515709	175476
547	Woodlands Road Estate	6 Isleworth	515523	176056
548	Worple Estate	6 Isleworth	516154	174891
550	Worton Estate	6 Isleworth	515592	175774
551	Worton Road Estate	6 Isleworth	515164	175481
552	Wynne Court	6 Isleworth	516399	175862

Table 15-10: Excluded loads with limited demand data

Appendix H – EC Appraisal

EC ID	EC Opportunity Name	Cluster	Easting	Northing	Location What Three Words
1	Car Park under Watermans	Brentford	518293	177706	///model.pipes.began
2	IvyBridge Social Housing	Isleworth	515821	174609	///ends.blitz.desk
3	Twickenham Stadium	Isleworth	515329	174301	///hedge.volunteered.locals
4	Redless Park Car Park	Isleworth	516047	175426	///bets.guess.broken
5	Isleworth Leisure Centre and Library	Isleworth	516067	175469	///trim.hails.tamed
6	West Middlesex University Hospital	Isleworth	516439	176278	///straw.pilots.hotels
7	Hayes Road Industrial Site	Cranford and Heston West	511065	178896	///adults.lasts.wink
8	London Borough of Hounslow Council: Vehicle maintenance	Hounslow Town Centre	514796	175770	///chose.secret.cities
9	Council land around Beavers Primary School	Central and Hounslow West	511219	175673	///successes.alarm.plan
10	The Heathland School	Central and Hounslow West	513043	174462	///sprint.lease.carry
11	Brent Lea Social Housing	Brentford	517261	177209	///staple.highs.barks
12	Ferry Quays Car Park	Brentford	517985	177504	///cult.mixer.scope
13	London Museum of Steam	Brentford	518848	178034	///daring.music.visual
14	Blenheim Centre Plantroom	Hounslow Town Centre	513856	175947	///backed.stacks.waddled
15	Beside Greenham House	Hounslow Town Centre	514953	175887	///transfers.sock.lies
16	Hounslow Cavalry Barracks	Central and Hounslow West	512091	175737	///image.plates.asks
17	Convent Way	Cranford and Heston West	511645	178477	///goes.tidy.pest
18	HMP YOI Feltham	Feltham	509046	172654	///clip.invent.causes
19	Leisure West	Feltham	510926	172923	///later.rang.flies
20	Springwest Academy	Feltham	511280	172828	///invent.asset.saints
21	GSK	Brentford	516904	177914	///chose.global.harder
22	Gillete Studios	Brentford	516186	177502	///salad.tone.rally
23	On site at Mogden	Isleworth	515262	174698	///firm.stews.fade
24	Brentford Towers	Brentford	518414	178069	///stared.doll.care

Table 15-11: Table of Energy Centre's Considered

		Option 1 - London Borough of Hounslow Council: Vehicle maintenance ECID 8		Option 2 - Blenheim Centre Plantroom ECID 14		Option 3 - Beside Greenham House ECID 15	
Name Ref	Weighting	Score	*Notes*	Score	*Notes*	Score	*Notes*
Access							
Utility Connections							
Implications for Current & Planned Use							
Suitability for Flueing							
Flood Risk							
Access to LZC Sources							
Land ownership							
Reliance on 3rd parties							
Future expansion capability							
Proximity to Heat Off takers							
Space Availability							
Visual Impact							
Environmental Impact							
Potential to achieve fully electrified solution							
Deliverability							
Programme Implications							
Impact to Residents							
Write off cost for existing plant							
Total Score (%)							

Table 15-12: Hounslow Town Centre Energy Centre Appraisals

		Option 1 - Heathland School ECID 10		Option 2 - Council Land around Beavers Primary School ECID 9		Option 3 - Hounslow Cavalry Barracks ECID 16	
Name Ref	Weighting	Score	*Notes*	Score	*Notes*	Score	*Notes*
Access							
Utility Connections							
Implications for Current & Planned Use							
Suitability for Flueing							
Flood Risk							
Access to LZC Sources							
Land ownership							
Reliance on 3rd parties							
Future expansion capability							
Proximity to Heat Off takers							
Space Availability							
Visual Impact							
Environmental Impact							
Potential to achieve fully electrified solution							
Deliverability							
Programme Implications							
Impact to Residents							
Write off cost for existing plant							
Total Score (%)							

Table 15-13: Central & Hounslow West Energy Centre Appraisals

		Option 1 - Convent Way ECID 17		Option 2 - Hayes Road Industrial ECID 7	
Name Ref	Weighting	Score	*Notes*	Score	*Notes*
Access					
Utility Connections					
Implications for Current & Planned Use					
Suitability for Flueing					
Flood Risk					
Access to LZC Sources					
Land ownership					
Reliance on 3rd parties					
Future expansion capability					
Proximity to Heat Offtakers					
Space Availability					
Visual Impact					
Environmental Impact					
Potential to achieve fully electrified solution					
Deliverability					
Programme Implications					
Impact to Residents					
Write off cost for existing plant					
Total Score (%)					

Table 15-14: Cranford & Heston West Energy Centre Appraisals

		Option 1 - HMP YOI Feltham - ECID 18		Option 2 - Leisure West - ECID 19		Option 3 - Springwest Academy - ECID 20	
Name Ref	Weighting	Score	*Notes*	Score	*Notes*	Score	*Notes*
Access							
Utility Connections							
Implications for Current & Planned Use							
Suitability for Flueing							
Flood Risk							
Access to LZC Sources							
Land ownership							
Reliance on 3rd parties							
Future expansion capability							
Proximity to Heat Off takers							
Space Availability							
Visual Impact							
Environmental Impact							
Potential to achieve fully electrified solution							
Deliverability							
Programme Implications							
Impact to Residents							
Write off cost for existing plant							
Total Score (%)							

Table 15-15: Feltham Energy Centre Appraisals

		Option 1 - Car Park under Watermans - ECID 1		Option 2 - Brent Lea Social Housing - ECID 11		Option 3 - Ferry Quays Car Park - ECID 12		Option 4 - London Museum of Steam - ECID 13	
Name Ref	Weighting	Score	*Notes*	Score	*Notes*	Score	*Notes*	Score	*Notes*
Access									
Utility Connections									
Implications for Current & Planned Use									
Suitability for Flueing									
Flood Risk									
Access to LZC Sources									
Land ownership									
Reliance on 3rd parties									
Future expansion capability									
Proximity to Heat Off takers									
Space Availability									
Visual Impact									
Environmental Impact									
Potential to achieve fully electrified solution									
Deliverability									
Programme Implications									
Impact to Residents									
Write off cost for existing plant									
Total Score (%)									

Table 15-16: Brentford Energy Centre Appraisals 1

		Option 5 - GSK - ECID 21	Option 6 - Gillete Studios - ECID 22	Option 7 - Brentford Towers Social Housing - ECID 24
Name Ref	W			
Access				
Utility Connections				
Implications for Current & Planned Use				
Suitability for Flueing				
Flood Risk				
Access to LZC Sources				
Land ownership				
Reliance on 3rd parties				
Future expansion capability				
Proximity to Heat Off takers				
Space Availability				
Visual Impact				
Environmental Impact				
Potential to achieve fully electrified solution				
Deliverability				
Programme Implications				
Impact to Residents				
Write off cost for existing plant				
Total Score (%)				

Table 15-17: Brentford Energy Centre Appraisals 2

		Option 1 - Ivybridge Social Housing - ECID 2		Option 2 - On site at Mogden - ECID 24		Option 3 - Twickenham Stadium - ECID 3	
Name Ref	Weighting	Score	*Notes*	Score	*Notes*	Score	*Notes*
Access							
Utility Connections							
Implications for Current & Planned Use							
Suitability for Flueing							
Flood Risk							
Access to LZC Sources							
Land ownership							
Reliance on 3rd parties							
Future expansion capability							
Proximity to Heat Off takers							
Space Availability							
Visual Impact							
Environmental Impact							
Potential to achieve fully electrified solution							
Deliverability							
Programme Implications							
Impact to Residents							
Write off cost for existing plant							
Total Score (%)							

Table 15-18: Isleworth Energy Centre Appraisals 1

		Option 4 - Redless Park Car Park - ECID 4		Option 5 - Isleworth Leisure Centre and Library - ECID 5		Option 6 - West Middlesex University Hospital - ECID 6	
Name Ref	Weighting	Score	*Notes*	Score	*Notes*	Score	*Notes*
Access							
Utility Connections							
Implications for Current & Planned Use							
Suitability for Flueing							
Flood Risk							
Access to LZC Sources							
Land ownership							
Reliance on 3rd parties							
Future expansion capability							
Proximity to Heat Off takers							
Space Availability							
Visual Impact							
Environmental Impact							
Potential to achieve fully electrified solution							
Deliverability							
Programme Implications							
Impact to Residents							
Write off cost for existing plant							
Total Score (%)							

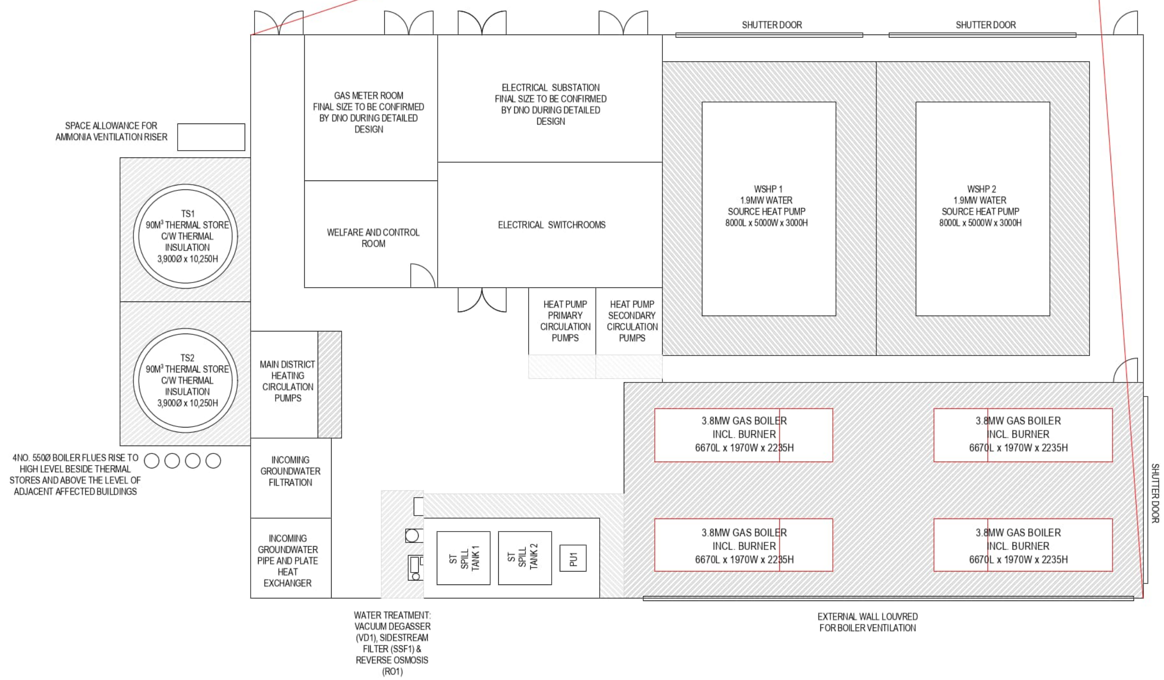
Table 15-19: Isleworth Energy Centre Appraisals 2

Appendix I – Energy Centre Layouts

Please refer to 60678525-ACM-EC-00-DR-ME-110001_Energy Centres.pdf issued as an accompaniment to this report.

PROPOSED POSITION ON SITE

NOTE:
1. ENERGY CENTRE INTERNAL FOOTPRINT: 700m^2
2. ENERGY CENTRE MAIN BUILDING FLOOR TO CEILING: 5m
3. LOSS OF CAR PARKING SPACES TO BE APPROVED



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AECOM

PROJECT

HOUNSLOW HEAT MAPPING & MASTERPLANNING

CLIENT

LONDON BOROUGH OF HOUNSLOW COUNCIL

CONSULTANT

AECOM
Aldgate Tower
2 Leman Street
London E1 8FA
www.aecom.com

KEY PLAN

GENERAL NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT DOCUMENTATION.
2. DO NOT SCALE FROM THIS DRAWING, USE ONLY STATED DIMENSIONS.
3. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE DESIGN, SIZING & SPECIFICATION OF ALL PLANT AND SERVICES IN ACCORDANCE WITH THE EMPLOYERS REQUIREMENTS AND INDUSTRY STANDARD GUIDANCE.
4. INTUMESCENT SEALS SHALL BE PROVIDED WHERE SERVICES PASS THROUGH FIRE COMPARTMENTS TO MAINTAIN THE INTEGRITY OF THE STRUCTURE.
5. ALL PLANT & EQUIPMENT SHALL BE INSTALLED IN ACCORDANCE WITH THE MANUFACTURERS RECOMMENDATIONS
6. ALL SERVICES SHALL BE PROVIDED WITH IDENTIFICATION BANDS & DIRECTIONAL FLOW INDICATION IN ACCORDANCE WITH BS1710
7. ALL PIPEWORK SHALL BE THERMALLY INSULATED AND CLAD FOLLOWING COMPLETION OF PRESSURE TESTING
8. ALL HOT WATER PIPEWORK PASSING THROUGH WALLS SHALL BE SLEEVED AND MADE GOOD TO ACCOMMODATE THERMAL EXPANSION AND CONTRACTION
9. ENERGY CENTRE TO BE NATURALLY VENTILATED FOR BOILER COMBUSTION IN ACCORDANCE WITH BS6644:2011 AND FOR THE DISSIPATION OF HEAT
10. INSTALLATION TO COMPLY WITH THE REQUIREMENTS OF AN ACOUSTIC REPORT AND FIRE STRATEGY

ISSUE/REVISION

01	29/07/22	Heat Mapping Stage
I/R	DATE	DESCRIPTION

PROJECT NUMBER

60678525

SHEET TITLE

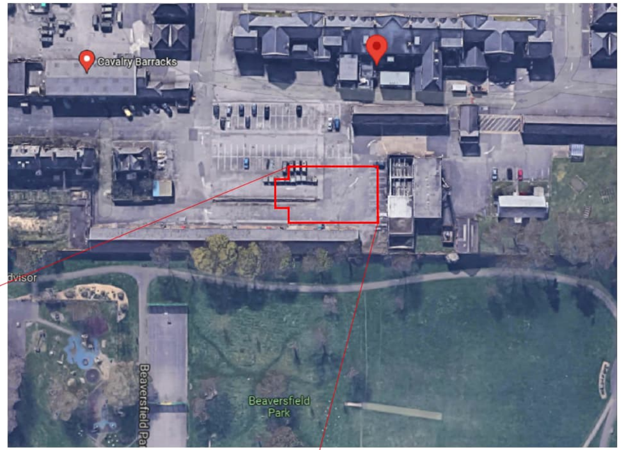
Hounslow Heat Mapping & Masterplanning
Hounslow Town Centre
Energy Centre Layout

SHEET NUMBER

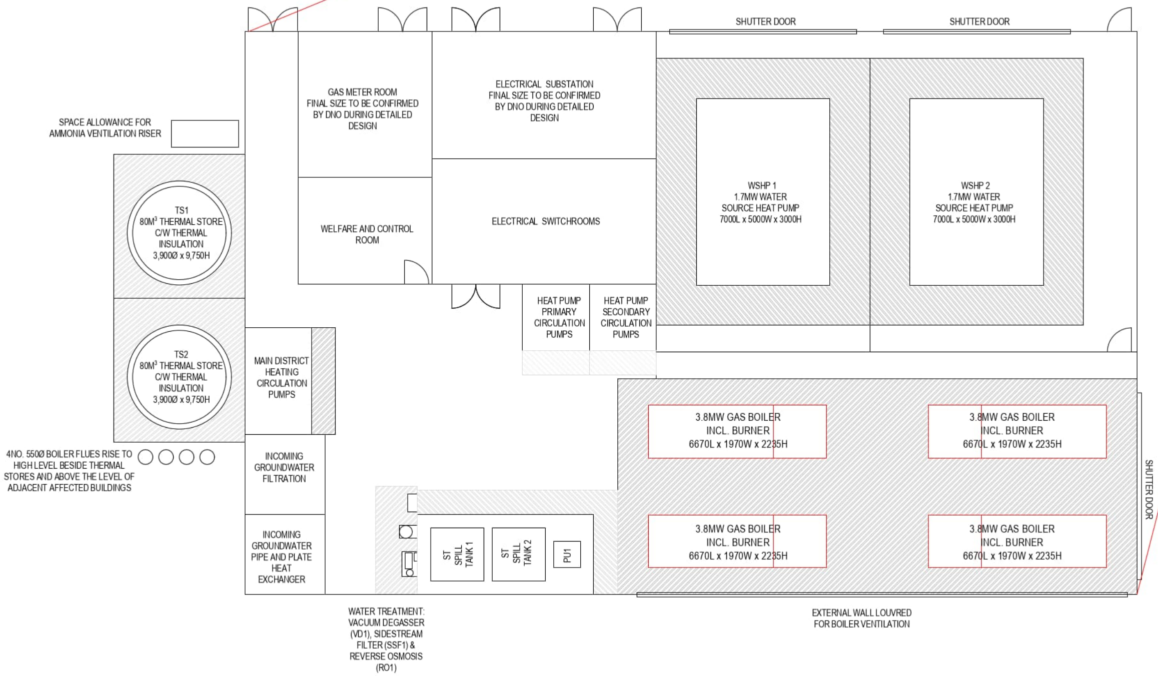
60678525-ACM-EC-00-DR-ME-110001

Project Management Initials: Designer: DMC Checked: AK Approved: RB ISO A1 594mm x 841mm

PROPOSED POSITION ON SITE



NOTE:
1. ENERGY CENTRE INTERNAL FOOTPRINT: $700m^2$
2. ENERGY CENTRE MAIN BUILDING FLOOR TO CEILING: 5m
3. POSITION ON SITE IS INDICATIVE, OFFERING ACCESS TO BEAVERSFIELD PARK FOR GROUND BOREHOLES BUT IS TO BE APPROVED BY THE CAVALRY BARRACKS



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Filename: L:\JOBS\DE - HOUNSLOW HMMP\900_CAD_GIS\910_CAD\60678525-ACM-EC-00-DR-ME-110001_ENERGY CENTRES.DWG

AECOM

PROJECT

HOUNSLOW HEAT MAPPING & MASTERPLANNING

CLIENT

LONDON BOROUGH OF HOUNSLOW COUNCIL

CONSULTANT

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Aldgate Tower
2 Leman Street
London E1 8FA
www.aecom.com

KEY PLAN

GENERAL NOTES

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4. INTUMESCENT SEALS SHALL BE PROVIDED WHERE SERVICES PASS THROUGH FIRE COMPARTMENTS TO MAINTAIN THE INTEGRITY OF THE STRUCTURE.
5. ALL PLANT & EQUIPMENT SHALL BE INSTALLED IN ACCORDANCE WITH THE MANUFACTURERS RECOMMENDATIONS
6. ALL SERVICES SHALL BE PROVIDED WITH IDENTIFICATION BANDS & DIRECTIONAL FLOW INDICATION IN ACCORDANCE WITH BS1710
7. ALL PIPEWORK SHALL BE THERMALLY INSULATED AND CLAD FOLLOWING COMPLETION OF PRESSURE TESTING
8. ALL HOT WATER PIPEWORK PASSING THROUGH WALLS SHALL BE SLEEVED AND MADE GOOD TO ACCOMMODATE THERMAL EXPANSION AND CONTRACTION
9. ENERGY CENTRE TO BE NATURALLY VENTILATED FOR BOILER COMBUSTION IN ACCORDANCE WITH BS6644:2011 AND FOR THE DISSIPATION OF HEAT
10. INSTALLATION TO COMPLY WITH THE REQUIREMENTS OF AN ACOUSTIC REPORT AND FIRE STRATEGY

ISSUE/REVISION

01	29/07/22	Heat Mapping Stage
I/R	DATE	DESCRIPTION

PROJECT NUMBER

60678525

SHEET TITLE

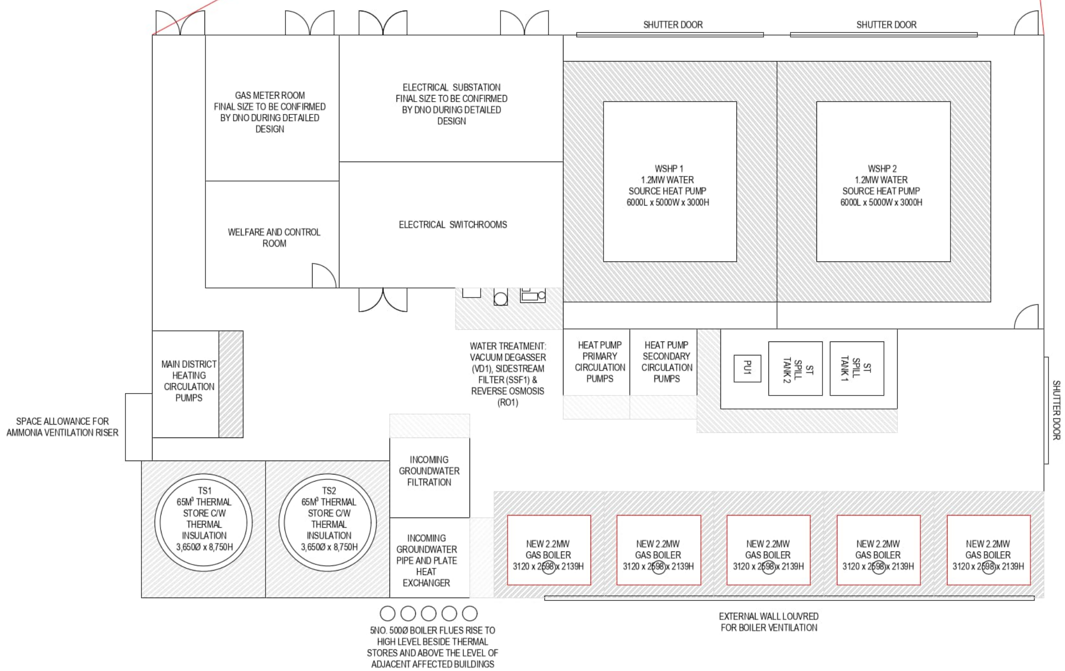
Hounslow Heat Mapping & Masterplanning
Central & Hounslow West
Energy Centre Layout

SHEET NUMBER

60678525-ACM-EC-00-DR-ME-110002

PROPOSED POSITION ON SITE

NOTE:
1. ENERGY CENTRE INTERNAL FOOTPRINT: 660m²
2. ENERGY CENTRE MAIN BUILDING FLOOR TO CEILING: 5m
3. EXTERNAL HARD STANDING AREA: 50m²
4. POSITION ON SITE IS PROPOSED TO OFFER ACCESS TO LONDON AIRLINKS GOLF COURSE FOR GROUND BOREHOLES, HOWEVER BOREHOLES ARE TO BE AGREED WITH COURSE OWNERS



SCALE: 1:100 @ A1

Project Management Initials: Designer: DMC Checked: AK Approved: RB ISO A1 594mm x 841mm

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AECOM

PROJECT
HOUNSLOW HEAT MAPPING & MASTERPLANNING

CLIENT
LONDON BOROUGH OF HOUNSLOW COUNCIL

CONSULTANT
AECOM
Aldgate Tower
2 Leman Street
London E1 8FA
www.aecom.com

KEY PLAN

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10. INSTALLATION TO COMPLY WITH THE REQUIREMENTS OF AN ACOUSTIC REPORT AND FIRE STRATEGY

ISSUE/REVISION

I/R	DATE	DESCRIPTION
01	29/07/22	Heat Mapping Stage

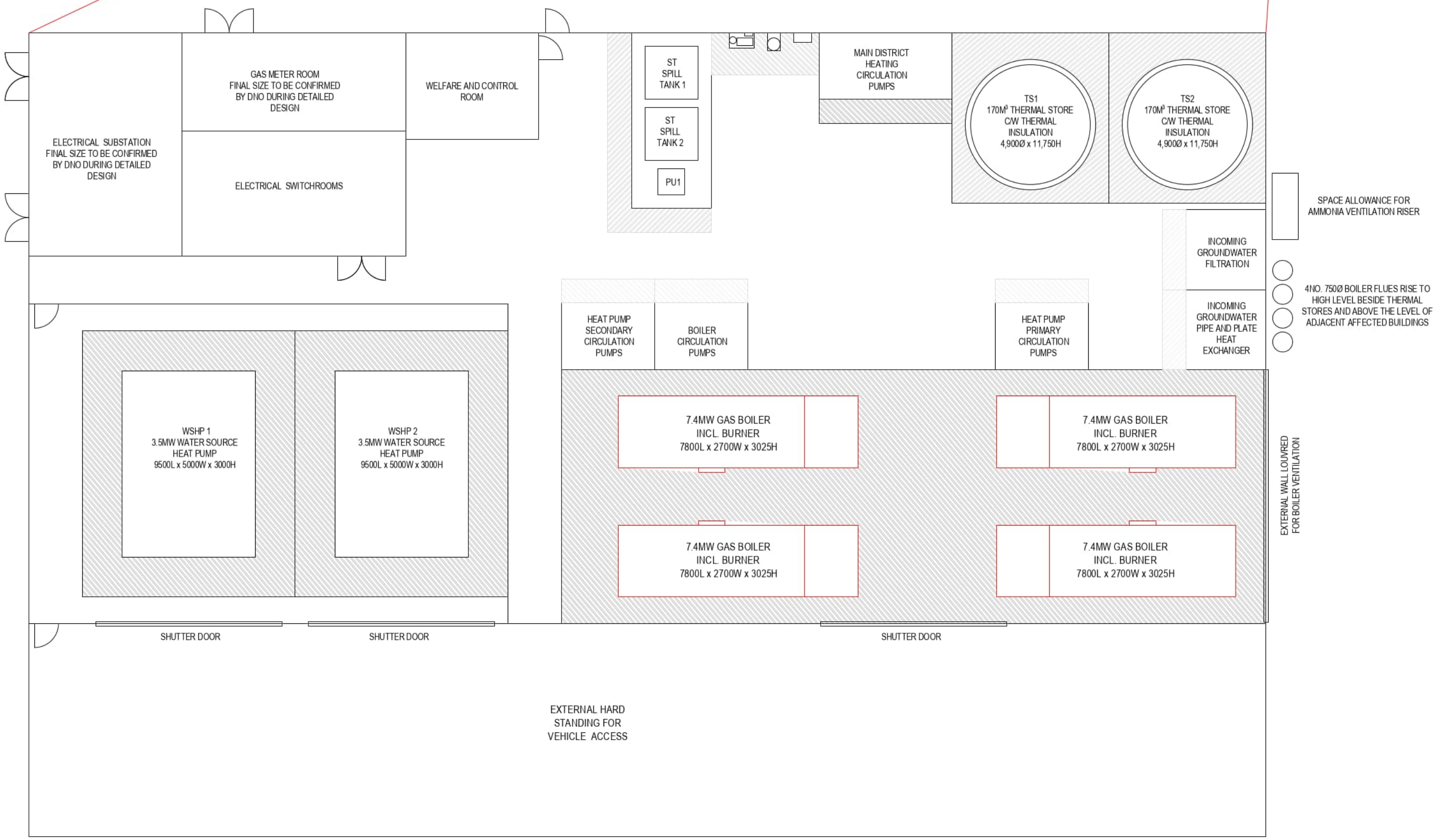
PROJECT NUMBER
60678525

SHEET TITLE
Hounslow Heat Mapping & Masterplanning
Cranford and Heston West
Energy Centre Layout

SHEET NUMBER
60678525-ACM-EC-00-DR-ME-110002

PROPOSED POSITION ON SITE

NOTE:
1. ENERGY CENTRE INTERNAL FOOTPRINT: 960m²
2. ENERGY CENTRE MAIN BUILDING FLOOR TO CEILING: 5m
3. EXTERNAL HARD STANDING AREA: 450m²
4. POSITION ON SITE IS INDICATIVE AND TO BE AGREED WITH THE ACADEMY
5. VENTILATION OF BOILER FLUES AND AMMONIA IN AN EMERGENCY SCENARIO IN PROXIMITY TO SCHOOL AND RESIDENTIAL BUILDINGS TO BE APPROVED



SCALE: 1:100 @ A1

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ISSUE/REVISION

I/R	DATE	DESCRIPTION
01	29/07/22	Heat Mapping Stage

PROJECT NUMBER

60678525

SHEET TITLE

Hounslow Heat Mapping & Masterplanning
Feltham
Energy Centre Layout

SHEET NUMBER

60678525-ACM-EC-00-DR-ME-110004

ISO A1 594mm x 841mm
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Checked: AK
Designer: DMC
Project Management Initials:
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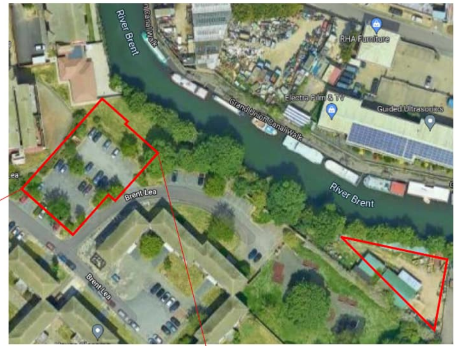
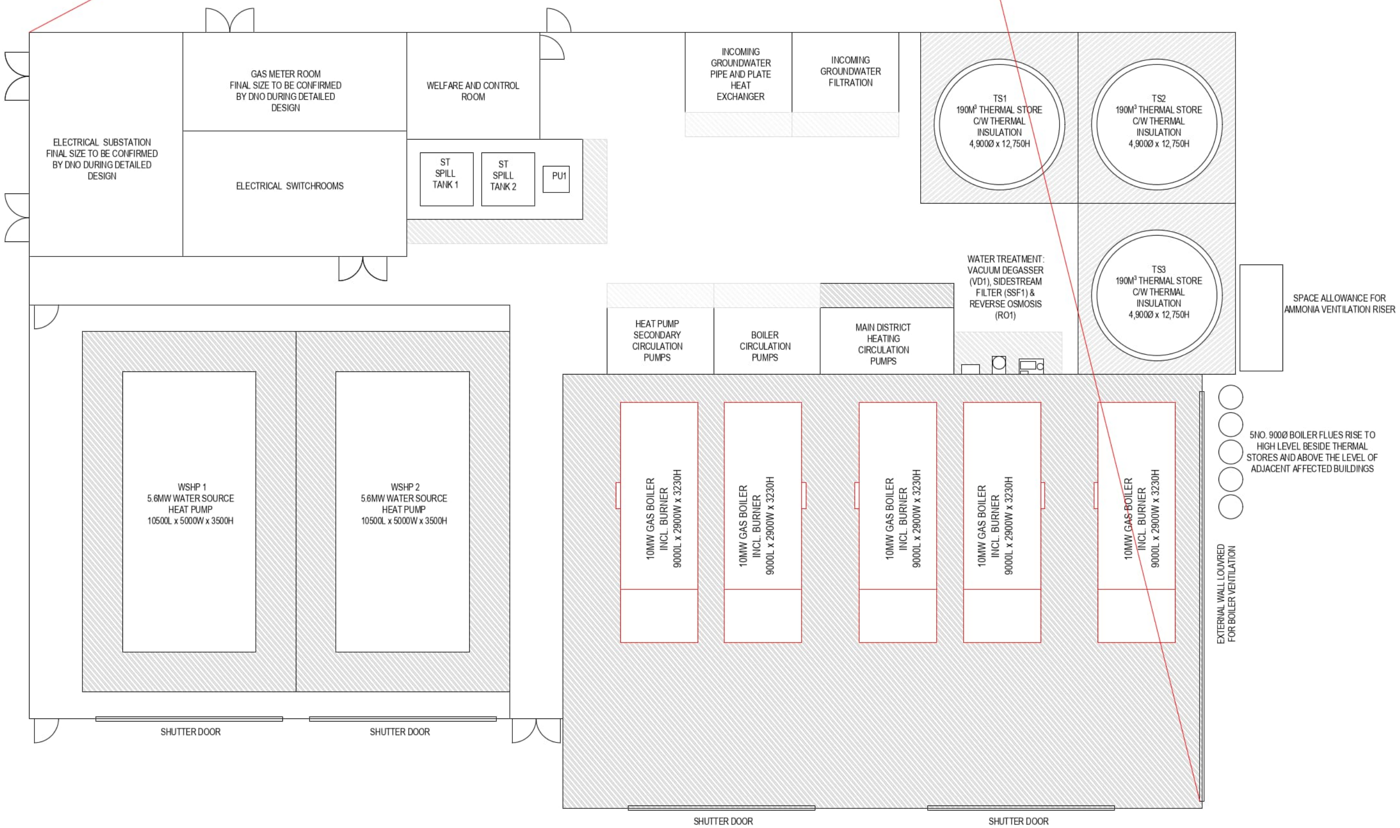
PROPOSED POSITION ON SITE



POTENTIAL ALTERNATIVE OR SUPPLEMENTARY LOCATION FOR ENERGY CENTRE

NOTE:
1. ENERGY CENTRE INTERNAL FOOTPRINT: 1,100m²
2. ENERGY CENTRE MAIN BUILDING FLOOR TO CEILING: 5m
3. EXTERNAL HARD STANDING AREA: 115m²
4. POSITION ON SITE IS PROPOSED TO OFFER ACCESS TO BOTH SYON PARK FOR GROUND BOREHOLES AND THE RIVER BRENT, SHOULD THE LATTER BE DETERMINED TO BE A PREFERRED TECHNOLOGY IN FUTURE STAGES



SCALE: 1:100 @ A1

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CLIENT

LONDON BOROUGH OF HOUNSLOW COUNCIL

CONSULTANT

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ISSUE/REVISION

I/R	DATE	DESCRIPTION
01	29/07/22	Heat Mapping Stage

PROJECT NUMBER

60678525

SHEET TITLE

Hounslow Heat Mapping & Masterplanning
Brentford
Energy Centre Layout

SHEET NUMBER

60678525-ACM-EC-00-DR-ME-110005

Project Management Initials: Designer: DMC Checked: AK Approved: RB ISO A1 594mm x 841mm

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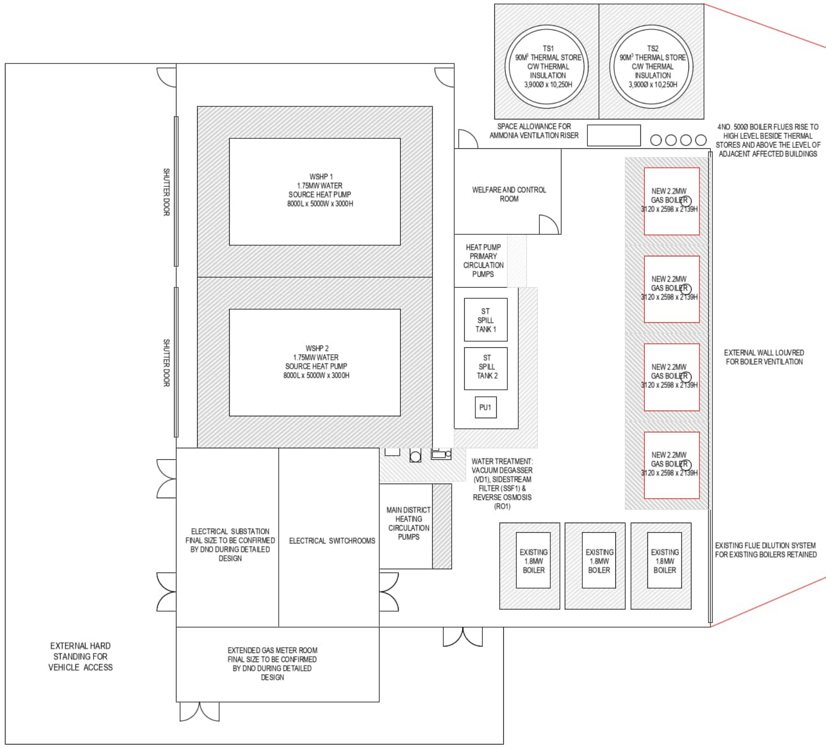
ISO A1 594mm x 841mm

Approved: RB

Checked: AK

Designer: DMC

Project Management Initials:



PROPOSED LAYOUT

NOTE:
1. ENERGY CENTRE INTERNAL FOOTPRINT: 640m²
2. ENERGY CENTRE MAIN BUILDING FLOOR TO CEILING: 5m
3. EXTERNAL HARD STANDING AREA: 300m²
4. SPACE IN THE ADJACENT BASEMENT LEVEL USED FOR MOGDEN PUMPING PLANT, LIMITED FABRIC WORKS ANTICIPATED FOR THIS ELEMENT
5. NEW LOCATION FOR RELOCATED EXISTING BOXING GYM REQUIRED

PROPOSED POSITION ON SITE

EXISTING LAYOUT

SCALE: 1:125 @ A1

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PROJECT

HOUNSLOW HEAT MAPPING & MASTERPLANNING

CLIENT

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CONSULTANT

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ISSUE/REVISION

I/R	DATE	DESCRIPTION
01	29/07/22	Heat Mapping Stage

PROJECT NUMBER

60678525

SHEET TITLE

Hounslow Heat Mapping & Masterplanning
Isleworth Network
Energy Centre Layout

SHEET NUMBER

60678525-ACM-EC-00-DR-ME-110006

ISO A1 594mm x 841mm
Approved: RB Checked: AK Designer: DMC Project Management Initials:
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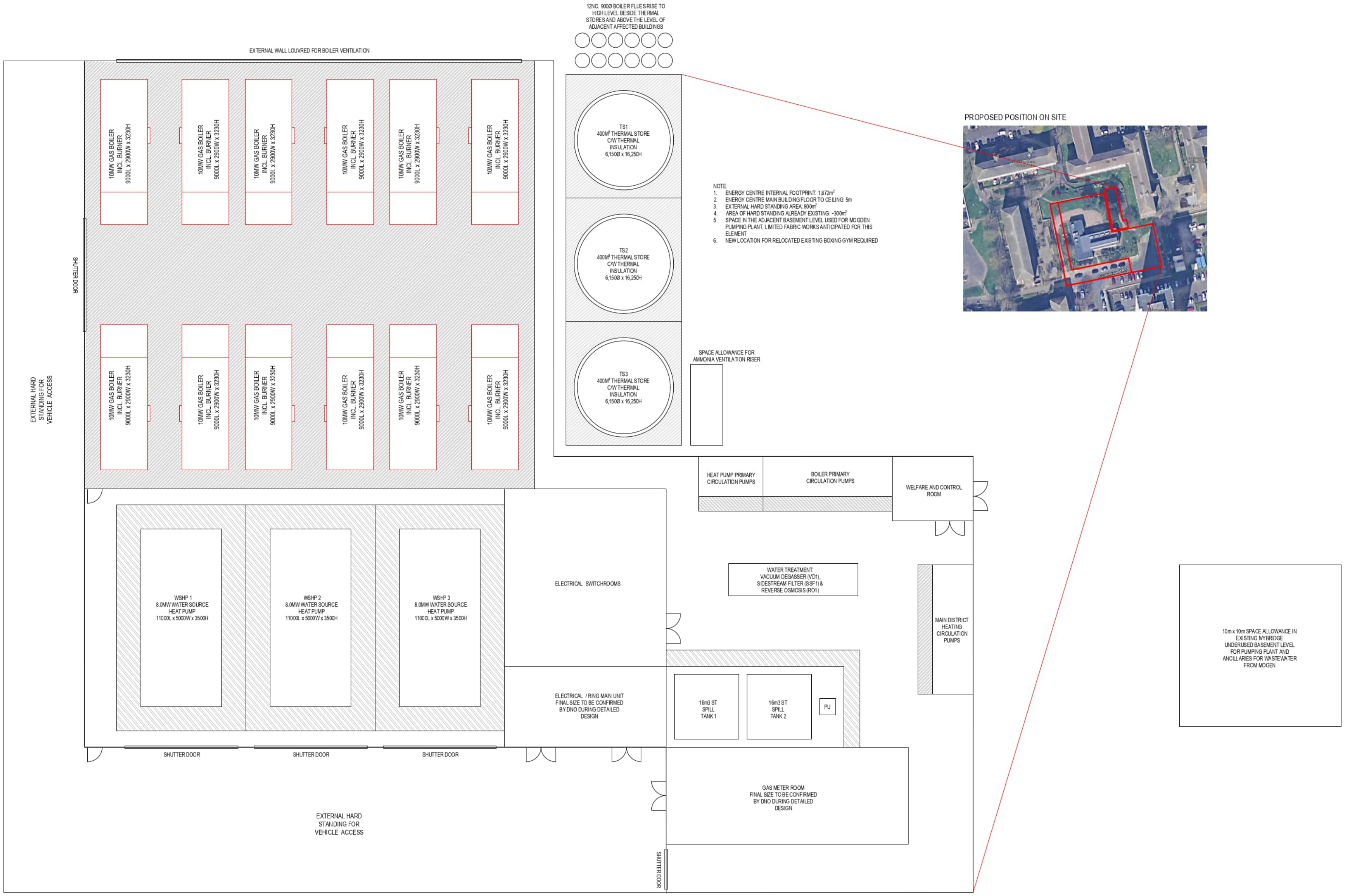

SCALE: 1:125 @ A1

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ISSUE/REVISION

01	29/07/22	Heat Mapping Stage
I/R	DATE	DESCRIPTION

PROJECT NUMBER

60678525

SHEET TITLE

Hounslow Heat Mapping & Masterplanning
Full Borough Network
Energy Centre Layout

SHEET NUMBER

60678525-ACM-EC-00-DR-ME-110007

Appendix J – LZC Appraisal

J.1 Heat Pump technology

A large number of low carbon technologies proposed within this list are centred around the use of heat pumps. A heat pump works using refrigeration cycle to convert low grade ambient (or waste) heat to that of a useful temperature. This requires electricity to facilitate this process but typically for every unit of electricity inputted into a heat pump, 2-5 units of useful heat are output for use into a heating system.

The efficiency of this process depends on the ambient heat source temperature and the heat supply temperature used by the building. The closer together these temperatures are, the more efficient is heat pump operation. Therefore, warmer heat sources (data centre waste heat and sewers) are preferable to cooler heat sources (such as air).

Heat can be extracted from a number of different ambient heat sources (air, water, ground, & sewers). The process can also be used to support the cogeneration of heating and cooling where both the cooled fluid and the warmed fluids are useful products. (see data centre heat rejection section for an example).

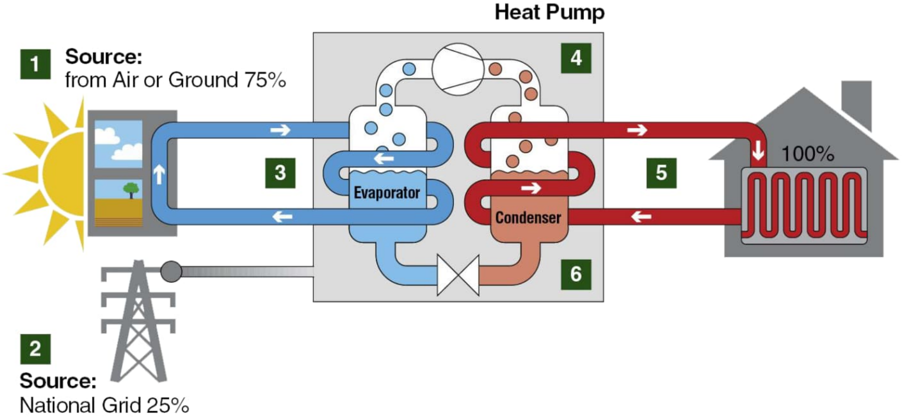

Figure 15-7; Heat Pump operation diagram (courtesy of Dimplex).

J.2 Ground Source Heat Pump

A Closed Loop GSHP system collects shallow ground energy held within the soil. The system incorporates an array of boreholes, typically 150m deep (or shallow trenches) within which plastic pipes are installed (coiled in shallow trenches). In order to extract the energy, a working fluid mixture of water and glycol is pumped through these plastic pipes, which is heated or cooled (as required) as it is pumped through the buried pipework. This is referred to as a Closed Loop GSHP System.

An Open Loop GSHP scheme typically involves the abstraction of groundwater from one or more boreholes which is then passed through a heat exchanger where heat is either extracted or added to the water, depending on whether the scheme is in a heating or cooling mode, and then discharged through another borehole or boreholes to the same aquifer as the abstracted water.

These boreholes should be at least 200m (horizontally) apart to ensure an efficient system and avoid recirculation of groundwater although in specific circumstances a reduced horizontal distance may be feasible depending on ground conditions.

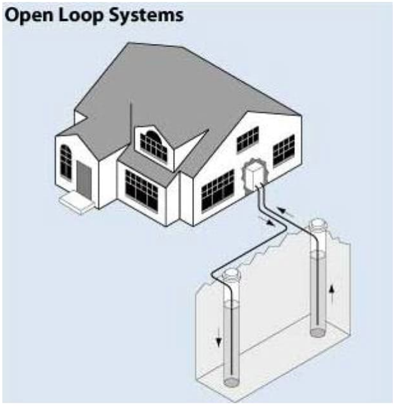

Figure 15-8: Overview of an open loop ground source heat pump https://www.energy.gov/energysaver/geothermal-heat-pumps

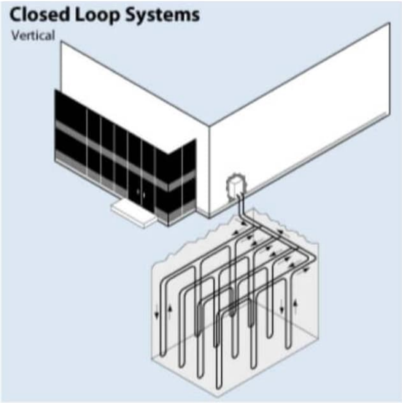

Figure 15-9: Overview of a closed loop ground source heat pump https://www.energy.gov/energysaver/geothermal-heat-pumps

J.3 Sewer Source Heat Pump

The wastewater within the sewer systems contains latent thermal energy. Sewage due to heated water discharge from showers, appliances and even rainwater can be harnessed. This heat is captured by abstracting and passing a percentage of the wastewater flow in any given sewer through a heat exchanger assembly, which is specially designed to account for the nature of the fluid, prior to reinjection back into the sewer.

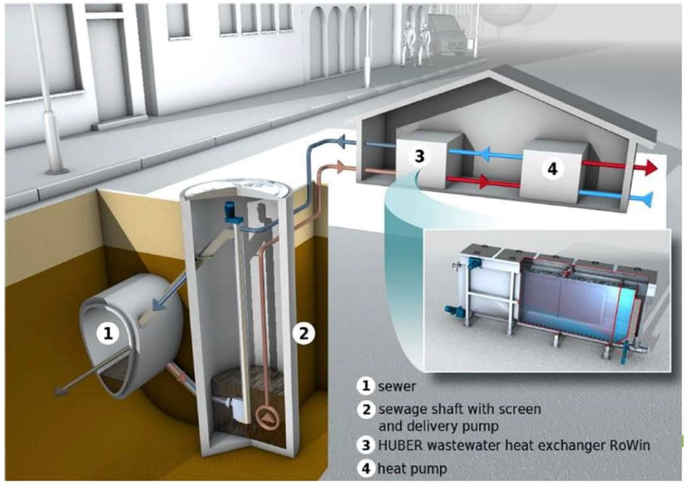

Figure 15-10: Overview of Landmark / Huber's technical solution. Note that alternative systems are commercially available. https://www.huber.co.uk/solutions/heating-and-cooling-with-wastewater/sewers-sources-of-energy.html

J.4 River/Marine Source Heat Pump

Marine source heat pumps collect ambient heat stored in sea water, rivers, canals or estuaries.

To abstract the required quantity of water, an open loop system is typically use, with a pipeline required to abstract the water prior to it passing through a heat exchanger prior to being rejected back out to sea.

The system operated much in the same way as an open-loop GSHP system, however the water abstraction system would likely be highly bespoke to every project as it is very much based upon the geographical conditions of the site.

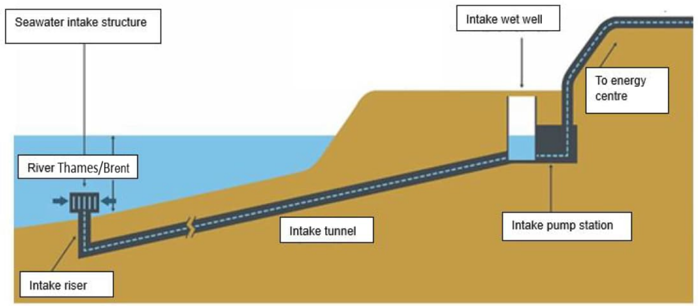

Figure 15-11: Illustration of seawater abstraction system.

J.5 Air Source Heat Pumps

Air Source Heat Pumps (ASHPs) extract energy from the ambient air and are able to function even when temperatures are as low as -5°C.

To extract energy from the ambient air, a portion of the equipment, the collector coil (which functions as either the condenser or compressor depending on if the heat pump is in heating or cooling mode respectively) is located externally. This is typically achieved by placing the coils on roof-spaces (which are flat to enable plant access) or at ground level, as illustrated in Figure 15-13 below:

Figure 15-13: Large capacity ASHP installation examples: Rooftop installation (left) or ground level installation (right, unit shown is 700kW in size and 8m in length, image courtesy of Star Refrigeration).

In order to absorb enough energy from the air, the resultant the collector coil(s) will need to be very large to serve the demands of a centralised district heating system, which typically results in the plant solution taking up a larger footprint than the other viable heat pump solutions discussed in this section.

J.6 Waste Heat from Data Centre

Data centres consume large amounts of power to provide their services to companies around the globe. These buildings are often design to 2kW of electrical demand per m² of floor area, this is at least 10 times greater than most buildings.

The electricity used by data centres is mostly converted to heat as the data leaving the building carries negligible amounts of energy. As such data centres need significant cooling to prevent them from overheating. In most data centres this heat is just rejected to the air. However, it could be harnessed to be used in heat pumps.

Data centres operate 365 days a year. The heat rejected by the server racks could be utilised to provide a consistent heat source (as opposed to the variable natural heat sources such as the air).

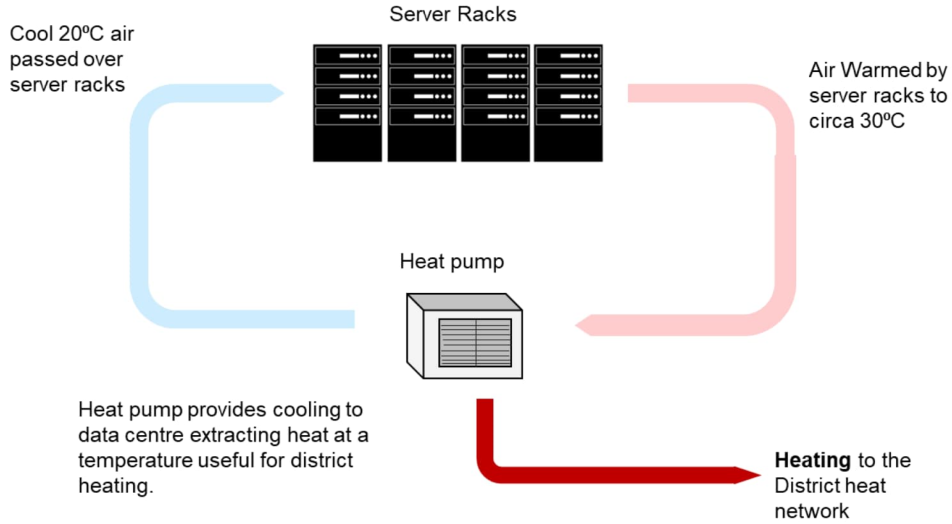

Figure 15-12: Simple schematic of data centre heat recovery.

J.7 Waste Heat from retail

Similarly, to data centres above, supermarkets required constant cooling for their refrigerators and freezers. This is a constant baseload required to make sure that chilled products remain at the specified temperature. The rejected heat (to provide cool) will usually be rejected externally via chillers, however a number of options are available.

The accessibility of this waste heat will depend on the MEP systems installed. Replacement cycles of refrigeration often afford the best opportunity to integreate waste heat recovery. The rejected heat can be used both within the supermarket and externally on a district energy network to ensure that all of the rejected heat is utilised. This opportunity has not been demonstrated at scale within the UK. Therefore, it is challenging to evaluate the potential of this technology and the impact it could make.

J.8 Waste Heat from Electrical Transformers

High voltage electrical transformers generation a significant amount of heat due to resistive losses. It is possible (although not widely implemented) to capture and utilise this heat whilst also improving transformer performance. Hot air is currently vented from substations to cool via oil cooling radiators. Instead a plate heat exchanger would extract heat from the cooling effluent and distribute via the district heat network.

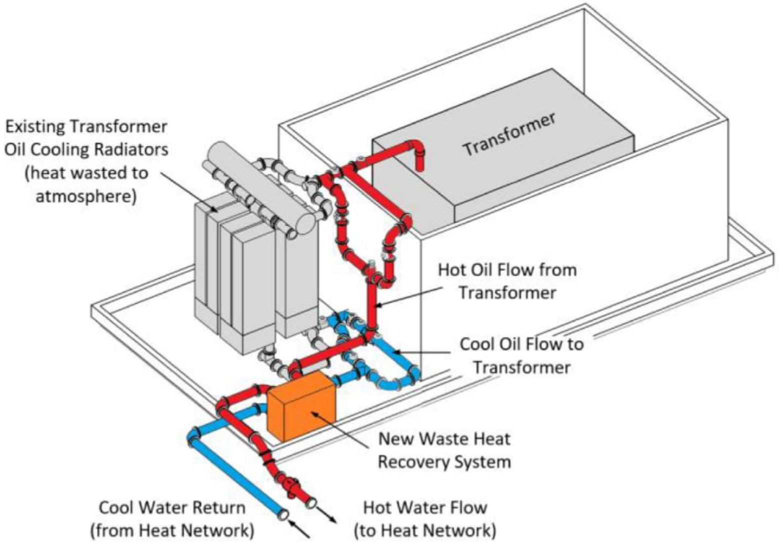

Figure 15-14: Diagram of HV transformer to District Energy thermal interface courtesy of SSE Energy Solutions

J.9 Appraisals

LZC ID	LZC Source Name	Cluster	Easting	Northing	Location What Three Words
1	Open loop surface water abstraction from the Thames	Brentford	518312	177677	///tuned.tummy.index
2	Open loop surface water abstraction from the Brent	Brentford	517278	177245	///person.fully.energetic
3	Open loop surface water abstraction from the Brent	Brentford	517399	177104	///tiger.stops.backup
4	Open loop ground water abstraction: Syon Park	Brentford	516939	176952	///votes.slime.sheet
5	Open loop ground water abstraction: St. Pauls Recreation Ground	Brentford	517853	177636	///area.drum.snake
6	Open loop ground water abstraction: Gunnersbury Park	Brentford	518549	178603	///tolls.cliff.longer
7	Open loop ground water abstraction: Boston Manor Park	Brentford	516796	177900	///froth.moment.showed
8	Open loop ground water abstraction: Goals Gillete Corner/Wyke Green Golf Course	Brentford	515837	177899	///eagles.secret.moth
9	Open loop ground water abstraction: Osterley Sports & Atheletics Centre	Brentford	515420	177193	///retire.sport.lifts
10	SSEN Electrical Transformer (Vicarage Farm Road)	Brentford	517036	178085	///onions.cherry.tulip
12	SSEN Electrical Transformer (Sungard)	Central and Hounslow West	511317	175618	///finds.risk.splice
13	Sungard Data Centre	Central and Hounslow West	511410	175596	///shirt.roof.spare
14	Open loop ground water abstraction at Hounslow Heath	Central and Hounslow West	512834	174371	///tanks.fees.hatch
15	SSEN Electrical Transformer (North Hyde)	Cranford and Heston West	510360	179066	///beyond.sung.badly
16	Open loop surface water abstraction from the grand union canal	Cranford and Heston West	510995	178924	///fled.crown.body
17	Open loop ground water abstraction at London air links golf course	Cranford and Heston West	511573	178343	///invite.stuff.burst
18	SSEN Electrical Transformer (North Feltham)	Central and Hounslow West	511002	174885	///apron.guess.closer
19	SSEN Electrical Transformer (Feltham)	Feltham	510655	172800	///dunes.holds.person
20	Open loop ground water abstraction at Lampton Park	Hounslow Town Centre	513217	176100	///vent.method.acted
21	SSEN Electrical Transformer (Bridge Road)	Hounslow Town Centre	514841	175780	///free.admiral.wells
22	Open loop ground water abstraction at Inwood Park	Hounslow Town Centre	514436	175576	///ozone.duke.beam
23	Open loop ground water abstraction at Thornby Park	Hounslow Town Centre	514994	175927	///body.dices.topped
24	Waste heat from the Blenham Centre	Hounslow Town Centre	513862	175950	///worry.fails.topped
25	Mogden STW Heat Recovery	Isleworth	515436	175026	///hotels.behind.shift
26	Waste Heat from Tesco	Isleworth	515601	174637	///landed.desire.trace
27	Open loop ground water abstraction at Redless Park	Isleworth	515938	175412	///punchy.silk.claps
28	Open loop ground water abstraction at Syon Park	Isleworth	516815	176437	///lungs.comical.zeal
30	Databank Feltham, Unit 4, Westgate Industrial Estate, Feltham TW14 8RS	Feltham	507585	173145	///bind.ranked.tides
31	Open loop ground water abstraction at Chester Road Park	Central and Hounslow West	510890	175860	///client.hosts.grapes
32	Leisure West Roof Air Source	Feltham	510890	172937	///flip.fade.sticks
33	Open loop ground water abstraction at Saint Dunstans Meadow	Feltham	509111	172544	///relate.caked.spirit
34	Heat Recovery from Asda Feltham Superstore Cooling	Feltham	510479	173159	///ocean.itself.beside
35	Open loop ground water abstraction at Hanworth Park	Feltham	511508	172743	///bolts.visa.local
36	Air Source Heat Pump @ London air Links Golf Course / Convent Way	Cranford and Heston West	511286	178688	///lion.forum.monday
37	Air Source Heat Pump @ Heathland School	Central and Hounslow West	512955	174373	///trace.repair.amber
38	Air Source Heat Pump @ LBH Council: Vehicle maintenance	Hounslow Town Centre	514790	175755	///splice.liked.valid
39	Air Source Heat Pump @ Ivybridge	Isleworth	515734	174589	///chill.topped.shape
40	Mogden STW Biogas CHP	Isleworth	515263	174788	///clots.square.tells
41	Open loop ground water abstraction at Beavers Park	Central and Hounslow West	512043	175871	///scarf.silent.solved
42	Open loop ground water abstraction at Cavalry Barracks	Central and Hounslow West	512089	175735	///image.plates.asks

Table 15-20: Table of LZC Considered

				Not viable with preferred EC		Not viable with preferred EC			
				Option 1	Option 2	Option 3	Option 4	Option 5	Option 6
Category	Name Ref								
Technical	Technology maturity and availability								
	Suitability for scale and profile of heat demand								
	Security of supply								
	Suitability for required supply temperatures								
	Proximity to heat demands								
Environmental	Level of CO2 emission savings								
	Air quality implications								
	Wider environmental impacts								
Financial	Technology cost								
	Impact on scheme financial viability								
	Long term financial risks								
Deliverability	Planning Implications								
	Implications for energy centre size/design								
	Implications for additional space requirements								
	Reliance on third parties								
Operational	Ease and cost of maintenance								
	Total score (%)								

Table 15-21: Hounslow Town Centre LZC Scoring - Year 0

				Not viable with preferred EC		Not viable with preferred EC			
				Option 1	Option 2	Option 3	Option 4	Option 5	Option 6
Category	Name Ref	Relevance/Importance	Weighting	Waste Heat from the Blenheim Centre cooling - LZCID 24	Ground Source Heat Pump @ Inwood Park - LZCID 22	Ground Source Heat Pump @ Lampton Park - LZCID 20	Ground Source Heat Pump @ Thornbury Park - LZCID 23	Electrical Transformer - LZCID 21	Air Source Heat Pump @ LBH Council: Vehicle maintenance - LZCID 38
Technical	Technology maturity and availability								
	Suitability for scale and profile of heat demand								
	Security of supply								
	Suitability for required supply temperatures								
	Proximity to heat demands								
Environmental	Level of CO2 emission savings								
	Air quality implications								
	Wider environmental impacts								
Financial	Technology cost								
	Impact on scheme financial viability								
	Long term financial risks								
Deliverability	Planning Implications								
	Implications for energy centre size/design								
	Implications for additional space requirements								
	Reliance on third parties								
Operational	Ease and cost of maintenance								
	Total score (%)								

Table 15-22: Hounslow Town Centre LZC Scoring - Year 15

Category	Name Ref	Relevance/ Importance	Weighting	Not viable with preferred EC Option 1 Sungard Data Centre Waste Heat - LZCID 13	Not viable with preferred EC Option 2 Sungard Electrical Transformer Waste Heat - LZCID 12	Not viable with preferred EC Option 3 Ground Source at Hounslow Heath - LZCID 14	Not viable with preferred EC Option 4 Ground Source at Chester Road Park - LZCID 31	Not viable with preferred EC Option 5 Air Source Heat Pump @ Heathland School - LZCID 37	Option 6 Ground Source at Beavers Park - LZCID 41	Option 7 Ground Source at Hounslow Cavalry Barrcaks - LZCID 42	Not viable with preferred EC Option 8 Electrical Transformer (North Feltham) - LZCID 18
Technical	Technology maturity and availability										
	Suitability for scale and profile of heat demand										
	Security of supply										
	Suitability for required supply temperatures										
	Proximity to heat demands										
Environmental	Level of CO2 emission savings										
	Air quality implications										
	Wider environmental impacts										
Financial	Technology cost										
	Impact on scheme financial viability										
	Long term financial risks										
Deliverability	Planning Implications										
	Implications for energy centre size/design										
	Implications for additional space requirements										
	Reliance on third parties										
Operational	Ease and cost of maintenance										
	Total score (%)										

Table 15-23: Central & Hounslow West LZC Scoring – Year 0

Category	Name Ref	Relevance/Importance	Weighting	Not viable with preferred EC Option 1 Sungard Data Centre Waste Heat - LZCID 13	Not viable with preferred EC Option 2 Sungard Electrical Transformer Waste Heat - LZCID 12	Not viable with preferred EC Option 3 Ground Source at Hounslow Heath - LZCID 14	Not viable with preferred EC Option 4 Ground Source at Chester Road Park - LZCID 31	Not viable with preferred EC Option 5 Air Source Heat Pump @ Heathland School - LZCID 37	Option 6 Ground Source at Beavers Park - LZCID 41	Option 7 Ground Source at Beavers Park - LZCID 42	Not viable with preferred EC Option 5 Electrical Transformer (North Feltham) - LZCID 18
Technical	Technology maturity and availability										
	Suitability for scale and profile of heat demand										
	Security of supply										
	Suitability for required supply temperatures										
	Proximity to heat demands										
Environmental	Level of CO2 emission savings										
	Air quality implications										
	Wider environmental impacts										
Financial	Technology cost										
	Impact on scheme financial viability										
	Long term financial risks										
Deliverability	Planning Implications										
	Implications for energy centre size/design										
	Implications for additional space requirements										
	Reliance on third parties										
Operational	Ease and cost of maintenance										
	Total score (%)	-									

Table 15-24: Central & Hounslow West LZC Scoring – Year 15

							Not viable with preferred EC
				Option 1	Option 2	Option 3	Option 4
Category	Name Ref	Relevance/Importance	Weighting	Water Source Heat Pump @ Grand Union Canal - LZCID 16	Ground Source Heat Pump @ London air Links Golf Course / Convent Way - LZCID	Air Source Heat Pump @ London air Links Golf Course / Convent Way - LZCID	Electrical Transformer (North Hyde) - LZCID 15
Technical	Technology maturity and availability						
	Suitability for scale and profile of heat demand						
	Security of supply						
	Suitability for required supply temperatures						
	Proximity to heat demands						
Environmental	Level of CO2 emission savings						
	Air quality implications						
	Wider environmental impacts						
Financial	Technology cost						
	Impact on scheme financial viability						
	Long term financial risks						
Deliverability	Planning Implications						
	Implications for energy centre size/design						
	Implications for additional space requirements						
	Reliance on third parties						
Operational	Ease and cost of maintenance						
	Total score (%)						

Table 15-25: Cranford & Heston West LZC Scoring - Year 0

							Not viable with preferred EC
				Option 1	Option 2	Option 3	Option 4
Category	Name Ref						
Technical	Technology maturity and availability						
	Suitability for scale and profile of heat demand						
	Security of supply						
	Suitability for required supply temperatures						
	Proximity to heat demands						
Environmental	Level of CO2 emission savings						
	Air quality implications						
	Wider environmental impacts						
Financial	Technology cost						
	Impact on scheme financial viability						
	Long term financial risks						
Deliverability	Planning Implications						
	Implications for energy centre size/design						
	Implications for additional space requirements						
	Reliance on third parties						
Operational	Ease and cost of maintenance						
	Total score (%)						

Table 15-26: Cranford & Heston West LZC Scoring - Year 15

				Not viable with preferred EC	Not viable with preferred EC	Not viable with preferred EC	Not viable with preferred EC	Not viable with preferred EC	
				Option 1	Option 2	Option 3	Option 4	Option 6	Option 7
Category	Name Ref	Relevance/Importance	Weighting	Ground Source Heat at St Dunstans Meadow - LZCID 33	Databank Feltham Heat Recovery - LZCID 30	Leisure West Roof Air Source Heat Pump - LZCID 32	Electrical Transformer (Feltham) - LZCID 19	Heat Recovery from Asda Feltham Superstore Cooling - LZCID 34	Ground Source Heat at Hanworth Park - LZCID 35
Technical	Technology maturity and availability								
	Suitability for scale and profile of heat demand								
	Security of supply								
	Suitability for required supply temperatures								
	Proximity to heat demands								
Environmental	Level of CO2 emission savings								
	Air quality implications								
	Wider environmental impacts								
Financial	Technology cost								
	Impact on scheme financial viability								
	Long term financial risks								
Deliverability	Planning Implications								
	Implications for energy centre size/design								
	Implications for additional space requirements								
	Reliance on third parties								
Operational	Ease and cost of maintenance								
	Total score (%)								

Table 15-27: Feltham LZC Scoring - Year 0

				Not viable with preferred EC	Not viable with preferred EC	Not viable with preferred EC	Not viable with preferred EC	Not viable with preferred EC	
				Option 1	Option 2	Option 3	Option 4	Option 6	Option 7
Category	Name Ref	Relevance/Importance	Weighting	Ground Source Heat at St Dunstans Meadow - LZCID 33	Databank Feltham Heat Recovery - LZCID 30	Leisure West Roof Air Source Heat Pump - LZCID 32	Electrical Transformer (Feltham) - LZCID 19	Heat Recovery from Asda Feltham Superstore Cooling - LZCID 34	Ground Source Heat at Hanworth Park - LZCID 35
Technical	Technology maturity and availability								
	Suitability for scale and profile of heat demand								
	Security of supply								
	Suitability for required supply temperatures								
	Proximity to heat demands								
Environmental	Level of CO2 emission savings								
	Air quality implications								
	Wider environmental impacts								
Financial	Technology cost								
	Impact on scheme financial viability								
	Long term financial risks								
Deliverability	Planning Implications								
	Implications for energy centre size/design								
	Implications for additional space requirements								
	Reliance on third parties								
Operational	Ease and cost of maintenance								
	Total score (%)								

Table 15-28: Feltham LZC Scoring - Year 15

				Not viable with preferred EC			Not viable with preferred EC	Not viable with preferred EC	Not viable with preferred EC	Not viable with preferred EC	Not viable with preferred EC	Not viable with preferred EC
				Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7	Option 8	Option 9
Category	Name Ref	Relevance/ Importance	Weighting	River Source Heat Pump @ Thames - LZCID 1	River Source Heat Pump @ Brent - LZCID 2 & 3	Ground Source Heat Pump @ Syon Park - LZCID 4	Ground Source Heat Pump @ Boston Manor Park - LZCID 7	Ground Source Heat Pump @ Goals or Osterley- LZCID 8 & 9	Air Source Heat Pump	Electrical Transformer - LZCID 10	Ground Source Heat Pump @ Gunnersbury Park - LZCID 6	Ground Source Heat Pump @ St. Pauls - LZCID 5
Technical	Technology maturity and availability											
	Suitability for scale and profile of heat demand											
	Security of supply											
	Suitability for required supply temperatures											
	Proximity to heat demands											
Environmental	Level of CO2 emission savings											
	Air quality implications											
	Wider environmental impacts											
Financial	Technology cost											
	Impact on scheme financial viability											
	Long term financial risks											
Deliverability	Planning Implications											
	Implications for energy centre size/design											
	Implications for additional space requirements											
	Reliance on third parties											
Operational	Ease and cost of maintenance											
	Total score (%)	-										

Table 15-29: Brentford LZC Scoring - Year 0

				Not viable with preferred EC			Not viable with preferred EC	Not viable with preferred EC	Not viable with preferred EC	Not viable with preferred EC	Not viable with preferred EC	Not viable with preferred EC
				Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7	Option 8	Option 9
Category	Name Ref	Relevance/ Importance	Weighting	River Source Heat Pump @ Thames - LZCID 1	River Source Heat Pump @ Brent - LZCID 2 & 3	Ground Source Heat Pump @ Syon Park - LZCID 4	Ground Source Heat Pump @ Boston Manor Park - LZCID 7	Ground Source Heat Pump @ Goals or Osterley- LZCID 8 & 9	Air Source Heat Pump	Electrical Transformer - LZCID 10	Ground Source Heat Pump @ Gunnersbury Park - LZCID 6	Ground Source Heat Pump @ St. Pauls - LZCID 5
Technical	Technology maturity and availability											
	Suitability for scale and profile of heat demand											
	Security of supply											
	Suitability for required supply temperatures											
	Proximity to heat demands											
Environmental	Level of CO2 emission savings											
	Air quality implications											
	Wider environmental impacts											
Financial	Technology cost											
	Impact on scheme financial viability											
	Long term financial risks											
Deliverability	Planning Implications											
	Implications for energy centre size/design											
	Implications for additional space requirements											
	Reliance on third parties											
Operational	Ease and cost of maintenance											
	Total score (%)	-										

Table 15-30: Brentford LZC Scoring - Year 15

					Not viable with preferred EC	Not viable with preferred EC			
				Option 1	Option 2	Option 3	Option 4	Option 5	Option 6
Category	Name Ref	Relevance/Importance	Weighting	Mogden STW Heat Recovery - LZCID 25	Ground Source Heat Pump @ Redless Park - LZCID 27	Ground Source Heat Pump @ Syon Park - LZCID 28	Air Source Heat Pump @ Ivybridge - LZCID 39	Waste Heat from Tesco - LZCID 26	Mogden STW Biogas CHP - LZCID 40
Technical	Technology maturity and availability								
	Suitability for scale and profile of heat demand								
	Security of supply								
	Suitability for required supply temperatures								
	Proximity to heat demands								
Environmental	Level of CO2 emission savings								
	Air quality implications								
	Wider environmental impacts								
Financial	Technology cost								
	Impact on scheme financial viability								
	Long term financial risks								
Deliverability	Planning Implications								
	Implications for energy centre size/design								
	Implications for additional space requirements								
	Reliance on third parties								
Operational	Ease and cost of maintenance								
	Total score (%)								

Table 15-31: Isleworth LZC Scoring – Year 0

					Not viable with preferred EC	Not viable with preferred EC			
				Option 1	Option 2	Option 3	Option 4	Option 5	Option 6
Category	Name Ref	Relevance/Importance	Weighting	Mogden STW Heat Recovery -	Ground Source Heat Pump @ Redless Park -	Ground Source Heat Pump @ Syon Park -	Air Source Heat Pump @ Ivybridge	Waste Heat from Tesco - LZCID 26	Mogden STW Biogas CHP -
Technical	Technology maturity and availability								
	Suitability for scale and profile of heat demand								
	Security of supply								
	Suitability for required supply temperatures								
	Proximity to heat demands								
Environmental	Level of CO2 emission savings								
	Air quality implications								
	Wider environmental impacts								
Financial	Technology cost								
	Impact on scheme financial viability								
	Long term financial risks								
Deliverability	Planning Implications								
	Implications for energy centre size/design								
	Implications for additional space requirements								
	Reliance on third parties								
Operational	Ease and cost of maintenance								
	Total score (%)								

Table 15-32: Isleworth LZC Scoring - Year 15

Appendix K – Hydrogeological Note

Geological summary:

British Geological Survey (BGS) geological maps and borehole records show that the study area lies where superficial deposits (Drifts), when present, overlain the London Clay, which generally outcrops in some parts of the area. The thickness of the superficial deposits, when present, ranges between 2.5m - 10m. The thickness of the London Clay varies between 50 - 80m over thin layers of Lambeth (<30m thick) and Thanet Sands (<5m thick) over the Chalk aquifer (Upper Chalk Formation, which has been proved up to at least 90m thick beneath the area.

Hydrogeological summary:

Hydrogeologically, the Chalk aquifer is the primary water-bearing unit beneath the Site. However, groundwater is likely present in the Thanet Sands above it, and both units are likely to be hydraulically connected. The Chalk typically has a low intergranular permeability but a high secondary permeability imparted by fractures and fissures, making it a dual-porosity system. Therefore, the bulk of the groundwater flow in the Chalk is predominantly controlled by the fracture system, which encourages rapid groundwater flow when present. The most pronounced fractures are generally found in the top 20m to 30m of the sequence, with less pronounced fractures with increased depth.

No recent groundwater level data is available for the area. However, the EA's latest publication on the groundwater level for the London Basin in 2018 indicated that the groundwater level in the Chalk beneath the study area ranges between -10m OD and 18m OD with an easterly/north easterly flow direction towards central London. Accordingly, the EA's Water table geology map indicated groundwater level as of 2018 lies within the London Clay, suggesting confining/piezometric groundwater condition beneath the area.

The EA assesses water availability within the Confined Chalk aquifer in the London area. The last reported assessment in 2018 suggests that water is available for licencing in areas where the piezometric level is above the surface of the Chalk, such as the study area.

Aquifer Hydraulic Properties:

The historical BGS borehole logs reviewed recorded abstraction rates of between <0.1l/sec and 13.89l/sec. The records indicated a wide variability and trend in the aquifer yielding capacity across the study area. Note: The purpose, construction method, and development of these historical boreholes may have affected their yields.

In 1995, a BGS study assessed over 600 borehole records for the London Basin and developed a method to predict borehole yields for a given location. The BGS 1995 research report includes a plot of standardised specific capacity (SSC) and a methodology to predict borehole yields from these data. Per the BGS SSC map, most of the study area falls in Zone B standardised specific capacity (SSC), where SSC ranges between 0.1 and 1m3/d/m, except for Site 3, which falls in Zone A, where SSC is >1m3/d/m. Accordingly, considering the inferred groundwater level estimated for the area and assuming a 20m maximum drawdown of 20m can be achieved from a single borehole drilled at any location within the study area, then a predicted yield ranges of 4.1l/s - 14l/s and 26.4l/s and 97.2l/s can be achieved from Zone B and Zone A respectively. Note: higher yields can be achieved than predicted, assuming borehole development by acidisation can increase borehole yield by about four-folds. In terms of transmissivity, as with the SSC, except for Site 3, which falls in an area of predicted transmissivity range of 15 - 150 m2/day, some of the sites fall in an area where the predicted transmissivity is <15m2/day. Conversely, calculated transmissivity from pumping test data from one of the BGS records (TQ17NW150) near Site 1, 2 and 7 indicated about 82m2/day transmissivity - suggesting higher yields/transmissivity may be achievable in the Zone B area than predicted.

Potential Constraints for the Proposed Scheme:

Note: If more than one abstraction borehole is required, spacing constraints between abstraction boreholes can impact the overall yield. The spacing between the abstraction and recharge wells can affect the system's efficiency. Ideally, these should be no less than 100m if possible. Also, the groundwater flow direction in relation to the borehole spacing/land dimension could pose further constraints. All of these must be considered in the planning and design of the abstraction and injection borehole configurations.

Conclusion:

Based on the above, subject to ground conditions and the anticipated yields proposed for each Site, and provided the constraints given above can be managed, it may be possible to achieve at least 50% of the proposed required yields at some of the Sites, except for Site 4, Site 5 and Site 6, with significantly higher yields of 140l/s and 205l/s, respectively. Accordingly, it may be possible to operate open loop GHSP at some sites, but this can only be established following the drilling and testing of a pilot borehole at each location to determine actual potential yields. This is summarised in Table 15-33.

Site Ref (Hydrogeological ref only)	Site Name	Aspirational Yield (l/s)	Preliminarily Assessment of Feasible Yield (l/s)
1 - HTC	Inwood Park	56	>33
2 - C & HW	Hounslow Cavalry Barracks	49	>28
3 - CF & HW	London Airlinks Golf Course	36	>23
4 - Feltham	Hanworth Park	105	<50
5 - Brentford 1	Syon Park	169	<50
6 - Brentford 2	Gunnersbury Park	169	<50

Table 15-33: Potential bore hole yield summary table

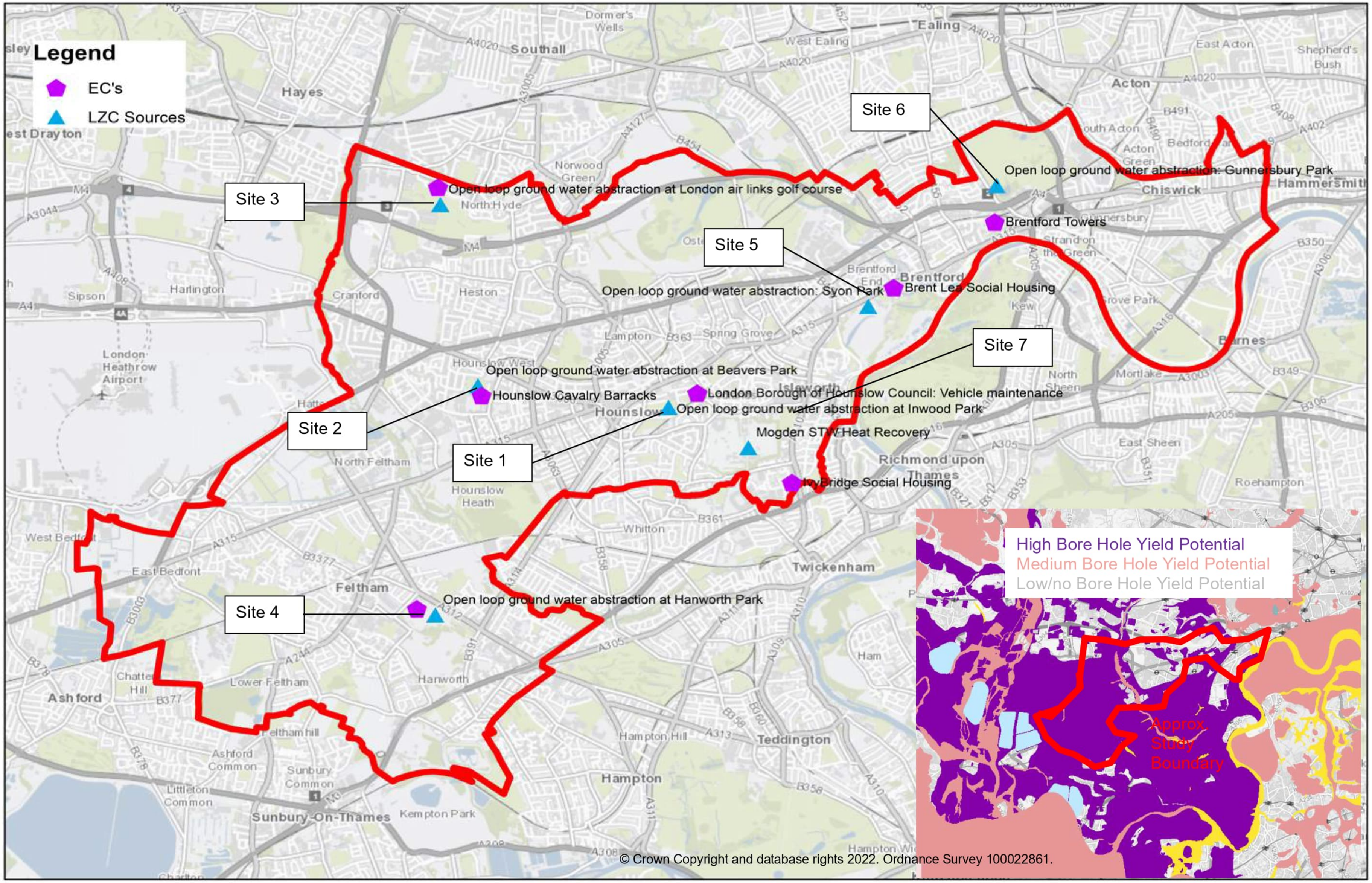

Figure 15-15: Map of proposed bore hole sites (large) and map of bore hole potential (small).

Appendix L – Utilities Budget Applications

Please refer to Utility Outgoing Applications issued as an accompaniment to this report.

North of Scotland 0800 048 3515
Central Southern England 0800 048 3516

Damien McCaul
AECOM INFRASTRUCTURE AND ENVIRONMENT
ALDGATE TOWER
2 LEMAN STREET
LONDON
E1 8FA

Connections and Engineering
Scottish and Southern Electricity Networks
Walton Park
Walton Road
Cosham
PO6 1UJ
07443175100
Khaled.rafaat@sse.com
www.ssen.co.uk

Our reference: EXC332

Your reference: N/A

28/07/2022

PROPOSED ELECTRICITY CONNECTION TO:

THE DEPOT - PEARS ROAD - HOUNSLOW - TW3 1SQ

Dear Damien,

Thank you for your recent enquiry. We have carried out a preliminary assessment of the works required to make connection to the distribution network in the area and we are pleased to provide you with our findings along with an estimate of the costs for the option identified. Please note that we have not carried out any detailed design work or network impact analysis. This budget estimate is provided as a result of a preliminary assessment only and possibly without any site specific considerations being taken into account. A budget estimate is not a formal offer for connection and cannot be accepted by you. The initial proposals will be subject to obtaining all necessary legal consents to carry out the work, including any consent required from third parties.

The estimate we provide at this stage may vary considerably from any further budget estimate or the price in any formal connection offer.

Budget estimate in the region of: £ 91,789.12

This budget estimate has been calculated exclusive of VAT and does not constitute an offer of terms.

The budget estimate has been calculated based on a high level assessment, the information you have provided and the assumptions listed within this letter. It is my best estimate of the costs you would incur for this proposal and is intended for budgetary purposes only. This estimate cannot be guaranteed. This estimate includes for any reinforcements assumed to be required on the wider network that may be triggered by this connection. This estimate does not include any assessment for temporary diversion or traffic management requirements. Any necessary reinforcements, temporary diversions or traffic management requirements would be confirmed

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North of Scotland 0800 048 3515
Central Southern England 0800 048 3516

in a formal connection offer, and part or all of the cost of these reinforcements would be included in the connection charge.

Any documents, drawings or figures provided as part of this budget estimate are indicative only.

There are Independent Connection Providers (ICPs) and Independent Distribution Network Operators (IDNOs) who may be able to provide you with an alternative quotation to carry out some of this work. Please refer to www.lloydsregister.co.uk for further details.

Description of proposed works and assumptions

1 x New HV metered substation with metering up to 3.8MVA to be installed on site to feed the site supply. HV POC will be provided, connection to be made via 2 x HV straight joints with approximately 2 x 65m of 240 XLPE to be laid from POC to substation. This estimate is based on the customer carrying out all on site excavation and reinstatement works and providing all internal containments for cables on-site.

The initial proposal includes the installation of 1 x new Distribution Substation on a 4.5m x 4.5m plot. The land for this will be provided by the customer at no cost to us. All associated legal costs shall be borne by the customer.

We have not carried out detailed design work or network studies to confirm that the network can accommodate the requested capacity of demand import. There is therefore no guarantee that this level of capacity will be available without completing further studies. As we have only carried out preliminary off-site investigations, physical, technical and wayleave assessments may mean that the proposals are not practical.

Any planned transmission works and dates may be subject to change.

Any network assessment carried out as part of a formal connection offer, will take into account these works and you may be required to pay an apportioned part of network investment. Further information can be found on our Network Capacity maps:

https://www.ssen.co.uk/ContractedDemand/

Please also be aware that any formal connection offer will be made under our current Connection Charging Methodology Statement. If you do progress with a connection then there may also be charges applied for the use of the distribution network, as set out in our Use of System Charging Statements. Copies of our charging statements can be found on our website at:

https://www.ssen.co.uk/Library/ChargingStatements

If you would like to discuss any aspect of this budget estimate please feel free to contact me at the details provided at the top of this letter. Otherwise if you'd like to progress towards a formal connection offer, please contact connections@sse.com quoting your reference number which can be found at the top of this letter. You can find further information regarding our process for new connections by visiting:

North of Scotland
0800 048 3515
Central Southern England
0800 048 3516

www.ssen.co.uk/Connections/UsefulDocuments.

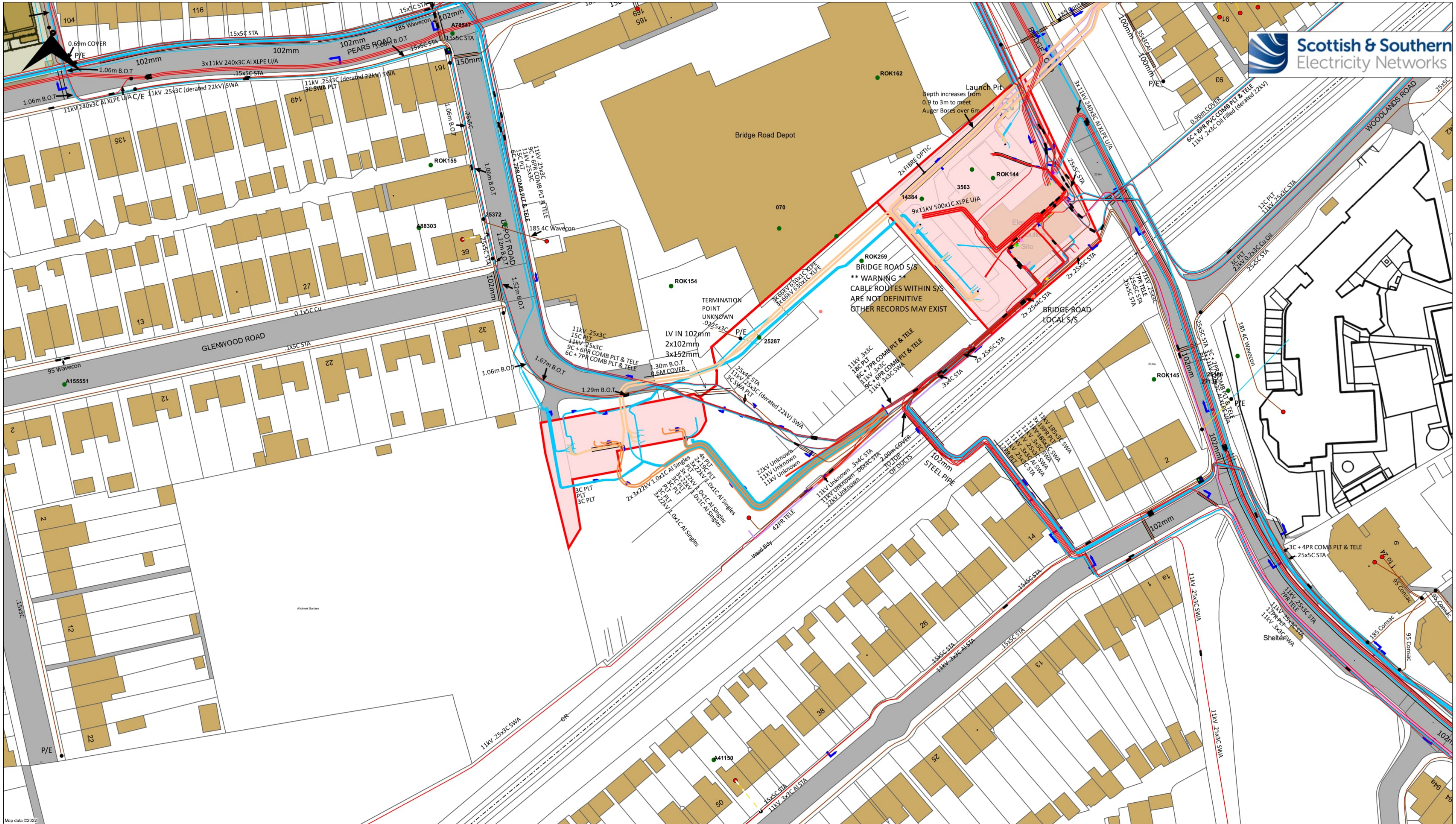
We look forward to hearing how you wish to progress with your project. Alternatively, you can find answers to any questions you may have on our web site www.ssen.co.uk.

Yours sincerely,

Khaled Rafaat

Connections Designer

Inveralmond House, 200 Dunkeld Road, Perth PH1 3AQ ssen.co.uk



WARNING

There may have been subsequent alterations to the surface levels. Trial holes must be taken to determine positions and depths of cables. HS (G) 47 Booklet from the Health and Safety Executive - Avoiding Danger from Buried Cables - should be consulted before commencing excavation work. WHEN WORKING IN THE VICINITY OF OVERHEAD LINES THE HEALTH AND SAFETY GUIDANCE NOTE GS6 SHOULD BE CONSULTED (AVAILABLE FROM THE HSE WEBSITE)

Map Centre: 514753, 175729

Grid Ref: TQ14757572

Scale: 1:1000

Page Size: A3

Plot Date: 26/07/2022

Designer Name: Rafaat, Khaled

Job Number:

UNCONTROLLED COPY
Subject to revision
Master held by SSEN Asset Data Team - Asset.Data@sse.com

If you are unsure & need to seek advice before commencing excavations please contact;

General Enquiries: 0800 048 3516

NORMAL DEPTH TO THE TOP OF THE CABLE WHEN LAID				
	Services	LV	HV	EHV
FOOTPATH/UNMADE	0.45m	0.45m	0.6m	0.8m
ROAD CROSSING	0.6m	0.6m	0.75m	0.9m
AGRICULTURAL	1m	1m	1m	1.1m

Legend

Main Report

Job Details

Job Reference	EXC332
Version	1
Estimate No.	2
Date Estimated	26-JUL-22

Estimate Summary List

Section Connection

Qty.	Description	Voltage	Cost(£)
55	TR.02.08.02 - HV Single 3 core cable - Car Type 2 flex	HV	19,083.80
55	TR.02.09.02 - Add HV 3 core cable - Car Type 2 flex	HV	9,827.49
2	JT.05.01 - HV Switch Term	HV	3,602.42
1	PL.04.07 - Shingle Substation	Misc	1,512.61
1	PL.03.01-Substation earthing HV / LV to TG-PS-073	Misc	2,938.29
1	New Conn HV - CT Metering	Misc	970.80
1	PL.01.18-GRP Housing type TR18	Misc	7,587.87
2	JB.01.03.04-HV straight/Pot end - Carriageway Type 2	HV	6,297.83
20	TR.05.08 - 11kV cable 3c lay & blind	Lay & Blind	528.78
130	240mm XLPE	HV	3,951.90
1	PL.01.06-Install RMU	Installation Costs	3,432.68
1	Traffic Management	Misc	4,929.60
1	Permits	Misc	208.00
1	SF6 RMU with Metering upto 3.8 MVA	Switchgear	18,135.13
		Total(£)	83,007.19

Section Final Connection

Qty.	Description	Voltage	Cost(£)
1	Padlocks (Operational) South	Misc	250.02
2	JT.04.01 - HV Straight Joint	HV	2,114.89
1	SD.01.05 - Deliver Shutdown cards (50-200)	Misc	1,417.02
1	SD.01.02 - HV shutdown	HV	5,000.02
		Total(£)	8,781.96

Estimate Summary List

Section	Other
	Other (£)
Other Costs - Rebate	0.00
Other Costs - 2nd Comer	0.00
Other Costs - O & M	0.00
Other Costs - High cost O & M	0.00
Total Other	0.00
DNO Costs (£)	0.00
Customer Costs (£)	91,789.14

Scottish & Southern Electricity Networks

North of Scotland 0800 048 3515
Central Southern England 0800 048 3516

Damien McCaul
AECOM INFRASTRUCTURE AND ENVIRONMENT
ALDGATE TOWER
2 LEMAN STREET
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Walton Road
Cosham
PO6 1UJ

07443175100

Khaled.rafaat@sse.com

www.ssen.co.uk

Our reference: EXC336

Your reference: N/A

28/07/2022

PROPOSED ELECTRICITY CONNECTION TO:

CRANFORD AND HESTON WEST ENERGY CENTRE - CONVENT WAY – SOUTHALL - UB2 5UN

Dear Damien,

Thank you for your recent enquiry. We have carried out a preliminary assessment of the works required to make connection to the distribution network in the area and we are pleased to provide you with our findings along with an estimate of the costs for the option identified. Please note that we have not carried out any detailed design work or network impact analysis. This budget estimate is provided as a result of a preliminary assessment only and possibly without any site specific considerations being taken into account. A budget estimate is not a formal offer for connection and cannot be accepted by you. The initial proposals will be subject to obtaining all necessary legal consents to carry out the work, including any consent required from third parties.

The estimate we provide at this stage may vary considerably from any further budget estimate or the price in any formal connection offer.

Budget estimate in the region of: £ 200,555.42

This budget estimate has been calculated exclusive of VAT and does not constitute an offer of terms.

The budget estimate has been calculated based on a high level assessment, the information you have provided and the assumptions listed within this letter. It is my best estimate of the costs you would incur for this proposal and is intended for budgetary purposes only. This estimate cannot be guaranteed. This estimate includes for any reinforcements assumed to be required on the wider network that may be triggered by this connection. This estimate does not include any assessment for temporary diversion or traffic management requirements. Any necessary reinforcements, temporary diversions or traffic management requirements would be confirmed

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North of Scotland 0800 048 3515
Central Southern England 0800 048 3516

in a formal connection offer, and part or all of the cost of these reinforcements would be included in the connection charge.

Any documents, drawings or figures provided as part of this budget estimate are indicative only.

There are Independent Connection Providers (ICPs) and Independent Distribution Network Operators (IDNOs) who may be able to provide you with an alternative quotation to carry out some of this work. Please refer to www.lloydsregister.co.uk for further details.

Description of proposed works and assumptions

1 x New HV metered substation with metering up to 1.5MVA to be installed on site to feed the site supply. HV POC will be provided, connection to be made via 2 x HV straight joints with approximately 2 x 320m of 240 XLPE to be laid from POC to substation. This estimate is based on the customer carrying out all on site excavation and reinstatement works and providing all internal containments for cables on-site.

The initial proposal includes the installation of 1 x new Distribution Substation on a 4.5m x 4.5m plot. The land for this will be provided by the customer at no cost to us. All associated legal costs shall be borne by the customer.

We have not carried out detailed design work or network studies to confirm that the network can accommodate the requested capacity of demand import. There is therefore no guarantee that this level of capacity will be available without completing further studies. As we have only carried out preliminary off-site investigations, physical, technical and wayleave assessments may mean that the proposals are not practical.

Any planned transmission works and dates may be subject to change.

Any network assessment carried out as part of a formal connection offer, will take into account these works and you may be required to pay an apportioned part of network investment. Further information can be found on our Network Capacity maps:

https://www.ssen.co.uk/ContractedDemand/

Please also be aware that any formal connection offer will be made under our current Connection Charging Methodology Statement. If you do progress with a connection then there may also be charges applied for the use of the distribution network, as set out in our Use of System Charging Statements. Copies of our charging statements can be found on our website at:

https://www.ssen.co.uk/Library/ChargingStatements

If you would like to discuss any aspect of this budget estimate please feel free to contact me at the details provided at the top of this letter. Otherwise if you'd like to progress towards a formal connection offer, please contact connections@sse.com quoting your reference number which can be found at the top of this letter. You can find further information regarding our process for new connections by visiting:

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Central Southern England
0800 048 3516

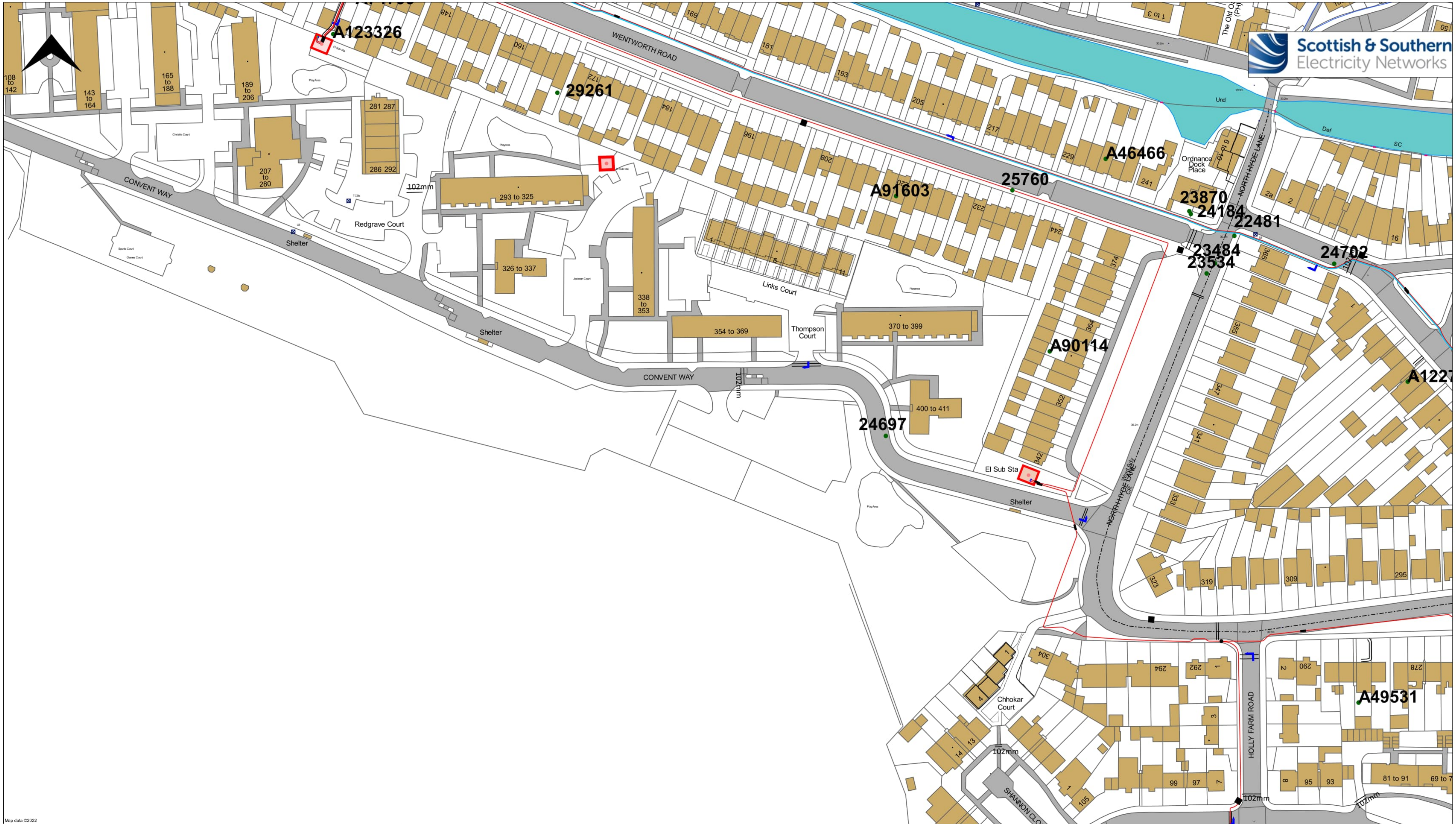
www.ssen.co.uk/Connections/UsefulDocuments.

We look forward to hearing how you wish to progress with your project. Alternatively, you can find answers to any questions you may have on our web site www.ssen.co.uk.

Yours sincerely,

Khaled Rafaat

Connections Designer



WARNING

There may have been subsequent alterations to the surface levels. Trial holes must be taken to determine positions and depths of cables. HS (G) 47 Booklet from the Health and Safety Executive - Avoiding Danger from Buried Cables - should be consulted before commencing excavation work. WHEN WORKING IN THE VICINITY OF OVERHEAD LINES THE HEALTH AND SAFETY GUIDANCE NOTE GS6 SHOULD BE CONSULTED (AVAILABLE FROM THE HSE WEBSITE)

Map Centre: 511806, 178430		Grid Ref: TQ11807842
Scale: 1:1500	Page Size: A3	Plot Date: 27/07/2022
Designer Name: Rafaat, Khaled		Job Number:

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Master held by SSEN Asset Data Team - Asset.Data@sse.com

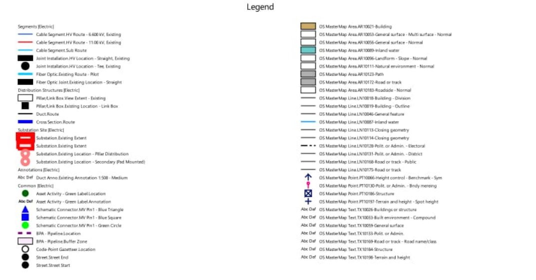
If you are unsure & need to seek advice before commencing excavations please contact;

General Enquiries	0800 048 3516

NORMAL DEPTH TO THE TOP OF THE CABLE WHEN LAID

	Services	LV	HV	EHV
FOOTPATH/UNMADE	0.45m	0.45m	0.6m	0.8m
ROAD CROSSING	0.6m	0.6m	0.75m	0.9m
AGRICULTURAL	1m	1m	1m	1.1m

Legend



Main Report

Job Details

Job Reference	EXC336
Version	1
Estimate No.	2
Date Estimated	27-JUL-22

Estimate Summary List

Section Connection

Qty.	Description	Voltage	Cost(£)
2	JT.05.01 - HV Switch Term	HV	3,602.42
1	PL.04.07 - Shingle Substation	Misc	1,512.61
1	PL.03.01-Substation earthing HV / LV to TG-PS-073	Misc	2,938.29
1	New Conn HV - CT Metering	Misc	970.80
1	PL.01.18-GRP Housing type TR18	Misc	7,587.87
2	JB.01.03.02-HV straight/Pot end - Footway (all types)	HV	3,499.95
20	TR.05.08 - 11kV cable 3c lay & blind	Lay & Blind	528.78
640	240mm XLPE	HV	19,455.49
1	PL.01.06-Install RMU	Installation Costs	3,432.68
1	Permits	Misc	208.00
1	RMU F/S	Switchgear	6,012.17
285	TR.01.08.02 - HV Single 3 core cable - Footway (all Type)	HV	67,254.29
285	TR.01.09.02 - Extra over for add HV 3 core cable - Footway	HV	33,624.80
25	TR.02.10.01 - Rd Xing / cable upto 11kV - Car Type 3/4 flex	HV	12,550.35
25	TR.02.11.01 - add cable in Rd Xing upto 11kV-Car Ty 3/4 flex	HV	6,463.53
1	Traffic Management	Misc	16,432.00
2	JT.04.01 - HV Straight Joint	HV	2,199.49
2	JB.01.03.02-HV straight/Pot end - Footway (all types)	HV	3,499.95
		Total(£)	191,773.47

Section Final Connection

Qty.	Description	Voltage	Cost(£)
1	Padlocks (Operational) South	Misc	250.02
2	JT.04.01 - HV Straight Joint	HV	2,114.89
1	SD.01.05 - Deliver Shutdown cards (50-200)	Misc	1,417.02
1	SD.01.02 - HV shutdown	HV	5,000.02
		Total(£)	8,781.96

Estimate Summary List

Section	Other
	Other (£)
Other Costs - Rebate	0.00
Other Costs - 2nd Comer	0.00
Other Costs - O & M	0.00
Other Costs - High cost O & M	0.00
Total Other	0.00
DNO Costs (£)	0.00
Customer Costs (£)	200,555.43

Scottish & Southern Electricity Networks

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Central Southern England 0800 048 3516

Damien McCaul
AECOM INFRASTRUCTURE AND ENVIRONMENT
ALDGATE TOWER
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LONDON
E1 8FA

Connections and Engineering
Scottish and Southern Electricity Networks
Walton Park
Walton Road
Cosham
PO6 1UJ
07443175100
Khaled.rafaat@sse.com
www.ssen.co.uk

Our reference: EXC340

Your reference: N/A

28/07/2022

PROPOSED ELECTRICITY CONNECTION TO:

FELTHAM ENERGY CENTRE – SPRINGWEST ACADEMY - BROWELLS LANE, FELTHAM - TW13 7EF

Dear Damien,

Thank you for your recent enquiry. We have carried out a preliminary assessment of the works required to make connection to the distribution network in the area and we are pleased to provide you with our findings along with an estimate of the costs for the option identified. Please note that we have not carried out any detailed design work or network impact analysis. This budget estimate is provided as a result of a preliminary assessment only and possibly without any site specific considerations being taken into account. A budget estimate is not a formal offer for connection and cannot be accepted by you. The initial proposals will be subject to obtaining all necessary legal consents to carry out the work, including any consent required from third parties.

The estimate we provide at this stage may vary considerably from any further budget estimate or the price in any formal connection offer.

Budget estimate in the region of: £ 89,881.62

This budget estimate has been calculated exclusive of VAT and does not constitute an offer of terms.

The budget estimate has been calculated based on a high level assessment, the information you have provided and the assumptions listed within this letter. It is my best estimate of the costs you would incur for this proposal and is intended for budgetary purposes only. This estimate cannot be guaranteed. This estimate includes for any reinforcements assumed to be required on the wider network that may be triggered by this connection. This estimate does not include any assessment for temporary diversion or traffic management requirements. Any necessary reinforcements, temporary diversions or traffic management requirements would be confirmed

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Central Southern England 0800 048 3516

in a formal connection offer, and part or all of the cost of these reinforcements would be included in the connection charge.

Any documents, drawings or figures provided as part of this budget estimate are indicative only.

There are Independent Connection Providers (ICPs) and Independent Distribution Network Operators (IDNOs) who may be able to provide you with an alternative quotation to carry out some of this work. Please refer to www.lloydsregister.co.uk for further details.

Description of proposed works and assumptions

1 x New HV metered substation with metering up to 3.8MVA to be installed on site to feed the site supply. HV POC will be provided, connection to be made via 2 x HV straight joints with approximately 2 x 145m of 240 XLPE to be laid from POC to substation. This estimate is based on the customer carrying out all on site excavation and reinstatement works and providing all internal containments for cables on-site.

The initial proposal includes the installation of 1 x new Distribution Substation on a 4.5m x 4.5m plot. The land for this will be provided by the customer at no cost to us. All associated legal costs shall be borne by the customer.

We have not carried out detailed design work or network studies to confirm that the network can accommodate the requested capacity of demand import. There is therefore no guarantee that this level of capacity will be available without completing further studies. As we have only carried out preliminary off-site investigations, physical, technical and wayleave assessments may mean that the proposals are not practical.

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Any network assessment carried out as part of a formal connection offer, will take into account these works and you may be required to pay an apportioned part of network investment. Further information can be found on our Network Capacity maps:

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Please also be aware that any formal connection offer will be made under our current Connection Charging Methodology Statement. If you do progress with a connection then there may also be charges applied for the use of the distribution network, as set out in our Use of System Charging Statements. Copies of our charging statements can be found on our website at:

https://www.ssen.co.uk/Library/ChargingStatements

If you would like to discuss any aspect of this budget estimate please feel free to contact me at the details provided at the top of this letter. Otherwise if you'd like to progress towards a formal connection offer, please contact connections@sse.com quoting your reference number which can be found at the top of this letter. You can find further information regarding our process for new connections by visiting:

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Central Southern England 0800 048 3516

www.ssen.co.uk/Connections/UsefulDocuments.

We look forward to hearing how you wish to progress with your project. Alternatively, you can find answers to any questions you may have on our web site www.ssen.co.uk.

Yours sincerely,

Khaled Rafaat

Connections Designer

Inveralmond House, 200 Dunkeld Road, Perth PH1 3AQ ssen.co.uk

WARNING
There may have been subsequent alterations to the surface levels. Trial holes must be taken to determine positions and depths of cables. HS (G) 47 Booklet from the Health and Safety Executive - Avoiding Danger from Buried Cables - should be consulted before commencing excavation work. WHEN WORKING IN THE VICINITY OF OVERHEAD LINES THE HEALTH AND SAFETY GUIDANCE NOTE GS6 SHOULD BE CONSULTED (AVAILABLE FROM THE HSE WEBSITE)

Map Centre: 511298, 172886		Grid Ref: TQ11297288	
Scale: 1:1500	Page Size: A3	Plot Date: 27/07/2022	
Designer Name: Rafaat, Khaled		Job Number:	

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If you are unsure & need to seek advice before commencing excavations please contact;

General Enquiries	0800 048 3516

NORMAL DEPTH TO THE TOP OF THE CABLE WHEN LAID

	Services	LV	HV	EHV
FOOTPATH/UNMADE	0.45m	0.45m	0.6m	0.8m
ROAD CROSSING	0.6m	0.6m	0.75m	0.9m
AGRICULTURAL	1m	1m	1m	1.1m

Legend

Main Report

Job Details

Job Reference	EXC340
Version	1
Estimate No.	2
Date Estimated	27-JUL-22

Estimate Summary List

Section Connection

Qty.	Description	Voltage	Cost(£)
2	JT.05.01 - HV Switch Term	HV	3,602.42
1	PL.04.07 - Shingle Substation	Misc	1,512.61
1	PL.03.01-Substation earthing HV / LV to TG-PS-073	Misc	2,938.29
1	New Conn HV - CT Metering	Misc	970.80
1	PL.01.18-GRP Housing type TR18	Misc	7,587.87
20	TR.05.08 - 11kV cable 3c lay & blind	Lay & Blind	528.78
1	SF6 RMU with Metering upto 3.8 MVA	Switchgear	18,135.13
290	240mm XLPE	HV	8,815.77
1	PL.01.06-Install RMU	Installation Costs	3,432.68
1	Permits	Misc	208.00
2	JB.01.03.02-HV straight/Pot end - Footway (all types)	HV	3,499.95
135	TR.01.08.01 - HV Single 3 core cable - Unmade/Turf	HV	18,041.60
135	TR.01.09.01 - Extra over for add HV 3 core cable-Unmade/Turf	HV	5,252.98
1	Traffic Management	Misc	6,572.80
		Total(£)	81,099.68

Section Final Connection

Qty.	Description	Voltage	Cost(£)
1	Padlocks (Operational) South	Misc	250.02
2	JT.04.01 - HV Straight Joint	HV	2,114.89
1	SD.01.05 - Deliver Shutdown cards (50-200)	Misc	1,417.02
1	SD.01.02 - HV shutdown	HV	5,000.02
		Total(£)	8,781.96

Estimate Summary List

Section	Other
	Other (£)
Other Costs - Rebate	0.00
Other Costs - 2nd Comer	0.00
Other Costs - O & M	0.00
Other Costs - High cost O & M	0.00
Total Other	0.00
DNO Costs (£)	0.00
Customer Costs (£)	89,881.64

Scottish & Southern Electricity Networks

North of Scotland **0800 048 3515**
Central Southern England **0800 048 3516**

Damien McCaul,
AECOM Infrastructure and Environment,
Aldgate Tower,
2 Leman Street,
London,
E1 8FA

Connections and Engineering
Scottish and Southern Electricity Networks
Walton Park
Walton Road
Cosham
PO6 1UJ
07436489106
Thomas.beebee@sse.com
www.ssen.co.uk

Our reference: **EXC325**

Your reference:

22nd August 2022

PROPOSED ELECTRICITY CONNECTION TO:

Brent Lea Estate, Brent Lea, Brentford, TW8 8HX – 6,220kVA Budget Quotation.

Dear Damien McCaul,

Thank you for your recent enquiry. We have carried out a preliminary assessment of the works required to make connection to the distribution network in the area and we are pleased to provide you with our findings along with an estimate of the costs for the option identified. Please note that we have not carried out any detailed design work or network impact analysis. This budget estimate is provided as a result of a preliminary assessment only and possibly without any site specific considerations being taken into account. A budget estimate is not a formal offer for connection and cannot be accepted by you. The initial proposals will be subject to obtaining all necessary legal consents to carry out the work, including any consent required from third parties.

The estimate we provide at this stage may vary considerably from any further budget estimate or the price in any formal connection offer.

Budget estimate in the region of: £ **140,000.00**

This budget estimate has been calculated exclusive of VAT and does not constitute an offer of terms.

The budget estimate has been calculated based on a high level assessment, the information you have provided and the assumptions listed within this letter. It is my best estimate of the costs you would incur for this proposal and is intended for budgetary purposes only. This estimate cannot be guaranteed. This estimate includes for any reinforcements assumed to be required on the wider network that may be triggered by this connection.

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This estimate does not include any assessment for temporary diversion or traffic management requirements. Any necessary reinforcements, temporary diversions or traffic management requirements would be confirmed in a formal connection offer, and part or all of the cost of these reinforcements would be included in the connection charge.

Any documents, drawings or figures provided as part of this budget estimate are indicative only.

There are Independent Connection Providers (ICPs) and Independent Distribution Network Operators (IDNOs) who may be able to provide you with an alternative quotation to carry out some of this work. Please refer to www.lloydsregister.co.uk for further details.

Description of proposed works and assumptions

Non-contestable elements:

- Assumed no HV reinforcement required for purpose of budget, however very likely has a dependency of approx 4 years based on previous knowledge of the area (will need to be confirmed at formal quotation stage to assess actual reinforcement dependencies).

- Assumed 2x HV straight joints as POC.

- HV shutdown, delivery cards and Padlocks required.

Contestable elements:

Assumed POC is correct and no HV reinforcement required.

- 2x HV joint bays in footpath.

- Assumed 2x 156m of HV excavations required to loop in new substation (78m Carriageway type 3/4 + Additional. 78m Footpath + Additional).

- Assumed 2x HV straight joints required for long length cable pull.

- HV metered SF6 RMU with metering between 3.9MVA and 7.8MVA.

- Assumed brick-built enclosure so no allowance for foundation or GRP included.

- 3x HV switch terminations.

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This estimate is based on the customer carrying out all on site excavation and reinstatement works and providing all internal containments for cables. I have included in this estimate a cost for the diversion of our existing cables and equipment that may be affected by your proposed development.

The initial proposal includes the installation of a new Distribution Substation on a 4m x 4m plot. The land for this will be provided by the customer at no cost to us. All associated legal costs shall be borne by the customer.

The initial proposal includes installing cable on third party land. Should you request a formal offer, consent from third parties may be required prior to commencement of works. This may affect the charge for the proposed connection.

We have not carried out detailed design work or network studies to confirm that the network can accommodate the requested capacity of demand import. There is therefore no guarantee that this level of capacity will be available without completing further studies. As we have only carried out preliminary off-site investigations, physical, technical and wayleave assessments may mean that the proposals are not practical.

Any planned transmission works and dates may be subject to change.

Any network assessment carried out as part of a formal connection offer, will take into account these works and you may be required to pay an apportioned part of network investment. Further information can be found on our Network Capacity maps:

https://www.ssen.co.uk/ContractedDemand/

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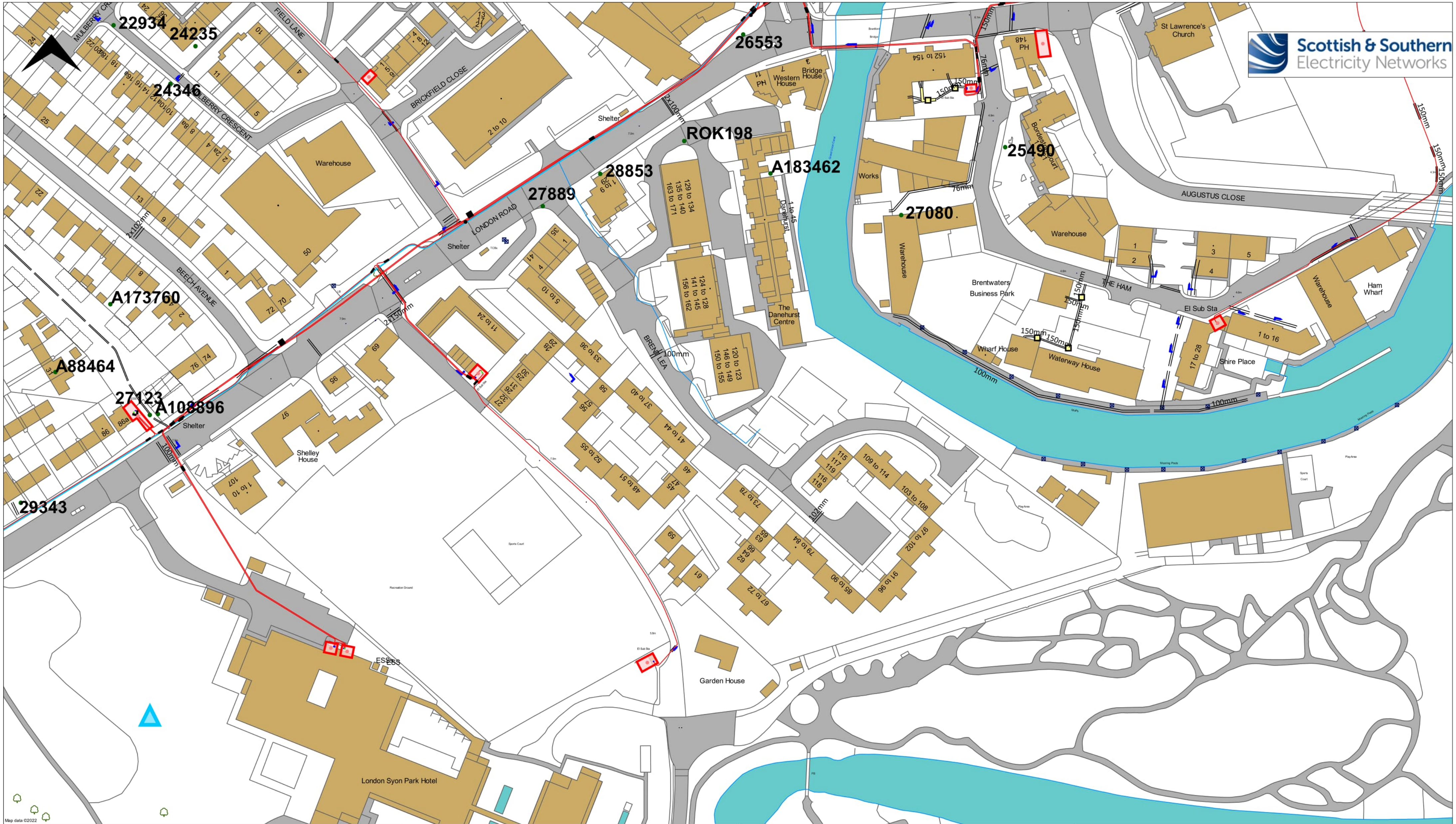
If you would like to discuss any aspect of this budget estimate please feel free to contact me at the details provided at the top of this letter. Otherwise if you'd like to progress towards a formal connection offer, please contact connections@sse.com quoting your reference number which can be found at the top of this letter. You can find further information regarding our process for new connections by visiting:

www.ssen.co.uk/Connections/UsefulDocuments.

We look forward to hearing how you wish to progress with your project. Alternatively, you can find answers to any questions you may have on our web site www.ssen.co.uk.

Yours sincerely,

Thomas Beebee - Connections Designer



WARNING

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Map Centre: 517243, 177127	Grid Ref: TQ17247712
Scale: 1:1500 / Page Size: A3	Plot Date: 22/08/2022
Designer Name: Beebee, Thomas	Job Number:

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If you are unsure & need to seek advice before commencing excavations please contact;

General Enquiries 0800 048 3516

NORMAL DEPTH TO THE TOP OF THE CABLE WHEN LAID	Services	LV	HV	EHV
FOOTPATH/UNMADE	0.45m	0.45m	0.6m	0.8m
ROAD CROSSING	0.6m	0.6m	0.75m	0.9m
AGRICULTURAL	1m	1m	1m	1.1m

Legend

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Central Southern England 0800 048 3516

Damien McCaul,
AECOM Infrastructure and Environment,
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London,
E1 8FA

Connections and Engineering
Scottish and Southern Electricity Networks
Walton Park
Walton Road
Cosham
PO6 1UJ
07436489106
Thomas.beebee@sse.com
www.ssen.co.uk

Our reference: **EXC331**

Your reference:

22nd August 2022

PROPOSED ELECTRICITY CONNECTION TO:

Ivybridge Estate, Summerwood Road, Isleworth, Hounslow, TW7 7QL – 1,890kVA Budget Quotation.

Dear Damien McCaul,

Thank you for your recent enquiry. We have carried out a preliminary assessment of the works required to make connection to the distribution network in the area and we are pleased to provide you with our findings along with an estimate of the costs for the option identified. Please note that we have not carried out any detailed design work or network impact analysis. This budget estimate is provided as a result of a preliminary assessment only and possibly without any site specific considerations being taken into account. A budget estimate is not a formal offer for connection and cannot be accepted by you. The initial proposals will be subject to obtaining all necessary legal consents to carry out the work, including any consent required from third parties.

The estimate we provide at this stage may vary considerably from any further budget estimate or the price in any formal connection offer.

Budget estimate in the region of: £ **63,000.00 – 75,000.00**

This budget estimate has been calculated exclusive of VAT and does not constitute an offer of terms.

The budget estimate has been calculated based on a high level assessment, the information you have provided and the assumptions listed within this letter. It is my best estimate of the costs you would incur for this proposal and is intended for budgetary purposes only. This estimate cannot be guaranteed. This estimate includes for any reinforcements assumed to be required on the wider network that may be triggered by this connection.

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This estimate does not include any assessment for temporary diversion or traffic management requirements. Any necessary reinforcements, temporary diversions or traffic management requirements would be confirmed in a formal connection offer, and part or all of the cost of these reinforcements would be included in the connection charge.

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Description of proposed works and assumptions

Non-contestable elements:

- Assumed no HV reinforcement required for purpose of budget, however very likely has a dependency of approx 4 years based on previous knowledge of the area (will need to be confirmed at formal quotation stage to assess actual reinforcement dependencies).

- 2x HV straight joints.

- HV shutdown, cards and padlocks.

Contestable elements:

Assumed POC is correct and no HV reinforcement required. Have not included for diversions of the existing substation as no proposed location to move to.

- 2x HV joint bays in carriageway.

- Assumed 2x 19m of HV excavations required to loop in new substation all carriageway depth.

- HV metered RMU with metering up to 3.8MVA

- 3x HV switch terminations.

This estimate is based on the customer carrying out all on site excavation and reinstatement works and providing all internal containments for cables. I have included in this estimate a cost for the diversion of our existing cables and equipment that may be affected by your proposed development.

The initial proposal includes the installation of a new Distribution Substation on a 4m x 4m plot. The land for this will be provided by the customer at no cost to us. All associated legal costs shall be borne by the customer.

Scottish & Southern Electricity Networks
Inveralmond House, 200 Dunkeld Road, Perth PH1 3AQ ssen.co.uk

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Central Southern England 0800 048 3516

The initial proposal includes installing cable on third party land. Should you request a formal offer, consent from third parties may be required prior to commencement of works. This may affect the charge for the proposed connection.

We have not carried out detailed design work or network studies to confirm that the network can accommodate the requested capacity of demand import. There is therefore no guarantee that this level of capacity will be available without completing further studies. As we have only carried out preliminary off-site investigations, physical, technical and wayleave assessments may mean that the proposals are not practical.

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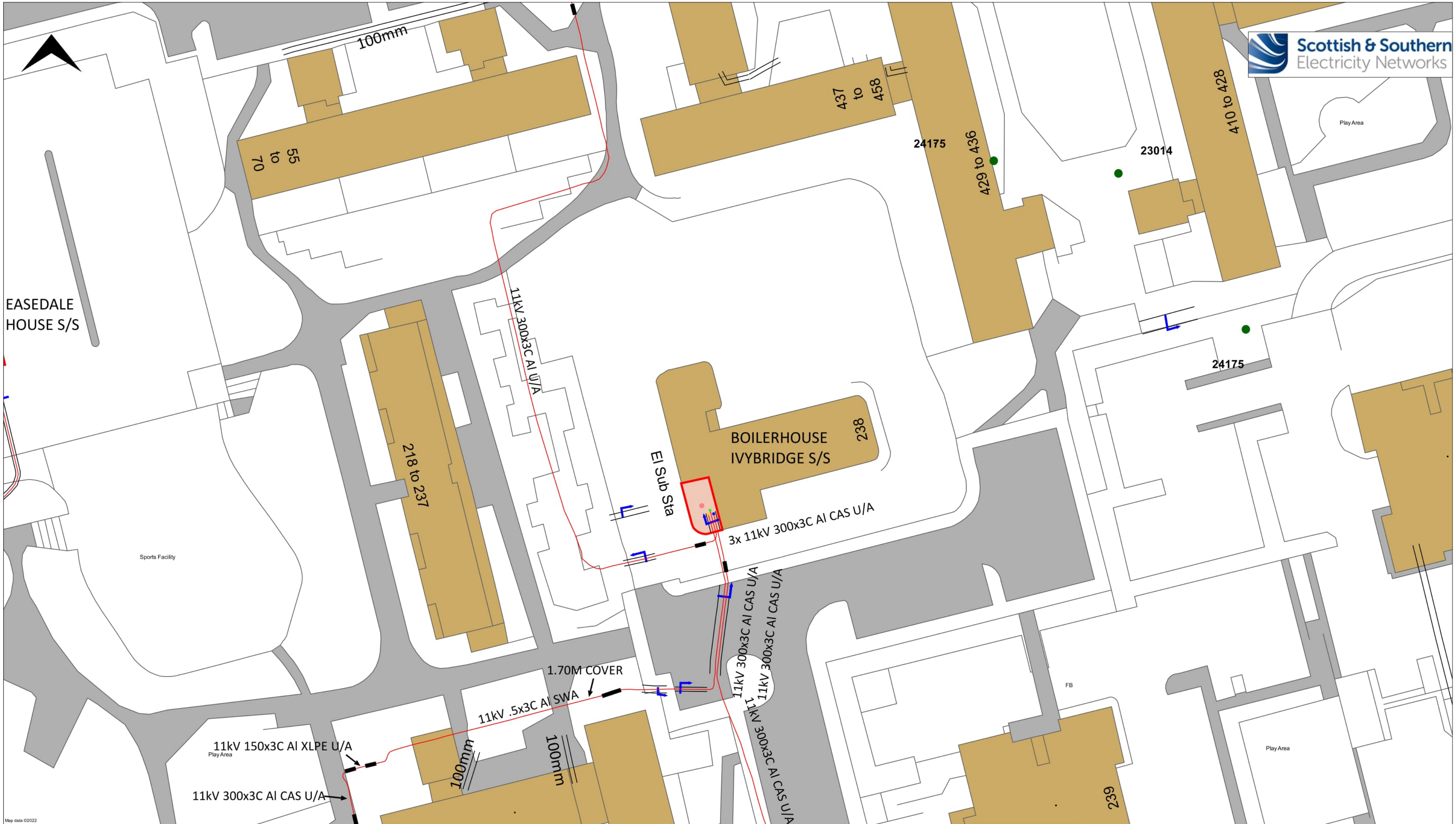
We look forward to hearing how you wish to progress with your project. Alternatively, you can find answers to any questions you may have on our web site www.ssen.co.uk.

Yours sincerely,

Thomas Beebee

Connections Designer



WARNING

There may have been subsequent alterations to the surface levels. Trial holes must be taken to determine positions and depths of cables. HS (G) 47 Booklet from the Health and Safety Executive - Avoiding Danger from Buried Cables - should be consulted before commencing excavation work. WHEN WORKING IN THE VICINITY OF OVERHEAD LINES THE HEALTH AND SAFETY GUIDANCE NOTE GS6 SHOULD BE CONSULTED (AVAILABLE FROM THE HSE WEBSITE)

Map Centre: 515817, 174615		Grid Ref: TQ15817461	
Scale: 1:500	Page Size: A3	Plot Date: 22/08/2022	
Designer Name: Beebee, Thomas		Job Number:	

UNCONTROLLED COPY
Subject to revision
Master held by SSEN Asset Data Team - Asset.Data@sse.com

If you are unsure & need to seek advice before commencing excavations please contact;

General Enquiries 0800 048 3516

NORMAL DEPTH TO THE TOP OF THE CABLE WHEN LAID	Services	LV	HV	EHV
FOOTPATH/UNMADE	0.45m	0.45m	0.6m	0.8m
ROAD CROSSING	0.6m	0.6m	0.75m	0.9m
AGRICULTURAL	1m	1m	1m	1.1m

Legend

Damien Mccaul
Aecom Infrastructure and Environment
Aldgate Tower
2 Leman Street
London
E1 8FA

Connections Design
Scottish and Southern Electricity Networks
Walton Park
Walton Rd
Portsmouth
PO6 1UJ

Date: 17/08/2022
If telephoning or calling please ask for: *Florence Osuagwu*
Tel No: +44 (0)7484 013369

Our Reference: *EXC458*
Your Reference:

PROPOSED ELECTRICITY CONNECTION TO: 13.1MVA DEMAND AT HOUNSLOW FULL BOROUGH ENERGY CENTRE, IVYBRIDGE ESTATE SUMMERWOOD ROAD, ISLEWORTH, HOUNSLOW TW7 7QL

Dear Damien,

Thank you for your enquiry regarding a budget estimate for a connection with an import/export of 13.1MVA/0MW from our electricity network. We have carried out a preliminary assessment of the works required to make connection to the distribution network in the area and we are pleased to provide you with our findings along with an estimate of the costs for the option identified. Please note that we have not carried out any detailed design work or network impact analysis. This budget estimate is provided as a result of a preliminary assessment only and possibly without any site-specific considerations being taken into account. You should note that the estimate we provide at this stage may vary considerably from any further budget estimate or the price in any formal connection offer. A budget estimate is not a formal offer for connection and cannot be accepted by you.

Import/Export 13.1MVA/0MW capacity connected at 33kV

The provisional works identified are as follows –

- 33kV Circuit Breaker (CB) connection into BRIDGE ROAD;
- 2.2 km of 33kV single circuit cable route from the Point of Connection (PoC) to the Point of Supply (PoS) at the customer's site;
- 33kV metering circuit breaker (CB) with Glass-Reinforced Plastic (GRP) housing and base;
- AVC check at BSP required;
- Harmonic check required;
- Active Network Management (ANM) Costs for the implementation of the SWAN (South West Active Network) scheme as required by National Grid;
- Tele control and metering;

The estimated cost for us to provide the Point of Connection to the existing distribution network is likely to be in the order of **£460,000 plus VAT**.

The estimated cost for us to provide the Point of Supply (all works up to DNO metering position) is likely to be in the order of **£2,500,000 plus VAT**.

A minimum of 24 months should be allowed for a PoC and 24 months for a PoS, following acceptance of a formal connection offer, to provide this connection. The completion time from acceptance of a formal offer could be reduced if detailed design work was carried out in advance of issuing the formal offer.

Network studies have not been carried out but it is likely that your generating station will be required to include the capability of operating in voltage control mode with a power factor operating range of **0.95 lead to 0.95 lag** in order to ensure the voltage levels on our network remain within statutory limits.

This connection may be subject to second comer charges.
This connection may trigger network reinforcements once formal detailed studies are carried out. Reinforcements could be due to thermal limitations, fault level issues with inadequate plant ratings or voltage level issues.
All indoor and outdoor connections at substations are subject to there being adequate physical space. Any space limitations may result in extending the building and/or site boundary and/or bus.
Timescales are indicative and subject to change.

Please note that this indicative price is based on the information provided, our interpretation of your requirements and current costs. This budget estimate allows for the construction of a suitable DNO substation compound. The proposed substation site will need to be of suitable size on level ground with adequate access for incoming and outgoing circuits and for larger vehicles. This estimate does not include any assessment for diversion requirements. We have not carried out detailed design work or network studies to confirm that the network can accommodate the requested capacity. There is therefore no guarantee that this level of capacity will be available without reinforcement works, which may be substantial. As we have only carried out preliminary off-site investigations, physical, technical and wayleave difficulties may mean that the proposals are not practical. We therefore reserve the right to amend the designs/prices accordingly and as a result they should only be used for budgetary purposes.

Distribution Constraints

Formal assessment required to confirm load capacity at Bridge Road BSP and whether connection is compliant with P2/7 security of supply standards.

Budget estimate assumes the cable route from PoC to PoS is readily available. Costs/timescales associated with securing cable route are excluded from budget estimate.

Connection is subject to formal assessment to determine any prohibitive issues concerning voltage, reverse power flow and 33kV and 132kV thermal rating.

Any network assessment carried out as part of a formal connection offer, will take into account these works and you may be required to pay an apportioned part of network investment, which may be a significant cost. Further information can be found on our generation availability heat map: *https://www.ssen.co.uk/GenerationAvailabilityMap/?mapareaid=2*

Transmission Constraints

Any planned transmission works may be subject to change.

There may be a requirement for SSEN to initiate a transmission assessment study or alternatively SSEN may be required to submit to NGET a request for a Statement of Works (should your project be 1 MW or above) for the purposes of identifying any necessary transmission reinforcements if you decide to progress with a formal connection offer. In the event that this is required there may also be a requirement for you to underwrite any required Transmission upgrades.

If determined as part of a formal assessment that a statement of works is needed, the application fee to NGET will be charged to the customer. NGET has 90 days to provide detailed information, including timescales, on the required transmission works. Further information on the Statement of Works process is set out in the CUSC Section 6, Clause 6.5.5. Further information can be found at:
www.nationalgrid.com/uk/Electricity/Codes/systemcode/contracts

Please also be aware that any formal connection offer will be made under our current Connection Charging Methodology Statement. If you do progress with a connection then there may also be charges applied for the use of the distribution network, as set out in our Use of System Charging Statements. Copies of our charging statements can be found on our website at:

https://www.ssen.co.uk/Library/ChargingStatements

If you would like to progress towards a formal connection offer, please contact Major Connections Contracts (email: MCC@sse.com, Tel: 0345 0724319). We look forward to hearing how you wish to progress with your project.

Yours sincerely,

Florence Osuagwu
Connections Designer

Appendix M – NOX & Particulate Emissions Assessment

Detailed flue gas dispersion modelling has not been undertaken during this study but should be completed as part of future design stages and will be required to be submitted as part of a planning application.

Due to the replacement of ageing Gas Boilers, 75° with a connection to district heating, for which the majority of heat generated is emission free (i.e., electrically fuelled heat pumps), the district heating network will provide a reduction in nitrogen oxide (NOx) emissions within the area served.

A high-level calculation has been undertaken to estimate the current and expected emission from the proposed networks. The assumptions made during this are detailed in Table 15-34 and accompanies the energy generation calculated in the technoeconomic analysis of this study. The results if this assessment are detailed in Table 15-35.

	Boiler Efficiency (%)[94]	NOx Emissions (mg/kWh)
Existing (Counterfactual) Gas Boilers, 75°	86%	100[95]
New Energy Centre Gas Boilers, 75°	90%	38[96]

Table 15-34: Assumptions of existing and new boiler performance

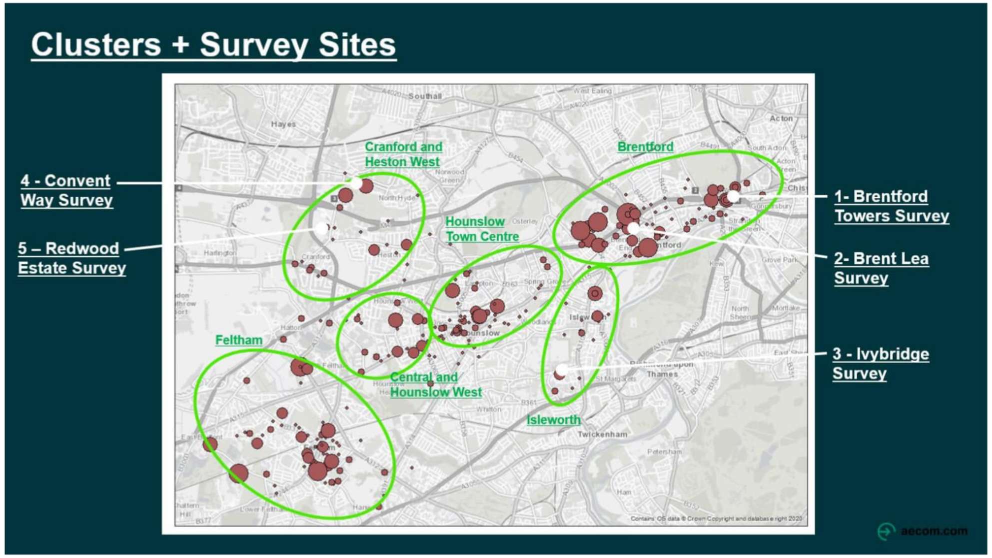
Network	Existing Boiler Gas Consumption (GWh)	Existing Boiler NOx Emissions (kg/year)	Energy Centre Boiler Gas Consumption (GWh)	Energy Centre NOx Emissions (kg/year)	NOx Emissions Reduction Provided by Network
Hounslow Town Centre	38.6	1,467	7.4	282	80.8%
Central & Hounslow West	33.3	1,264	6.4	244	80.7%
Cranford & Heston West	26.4	1,003	5.4	204	79.6%
Feltham	82.3	3,128	15.9	603	80.7%
Brentford	117.8	4,476	25.3	960	78.6%
Isleworth	43.4	1,648	9.4	356	78.4%
Full Borough	315.1	11,974	89.0	3,382	71.8%

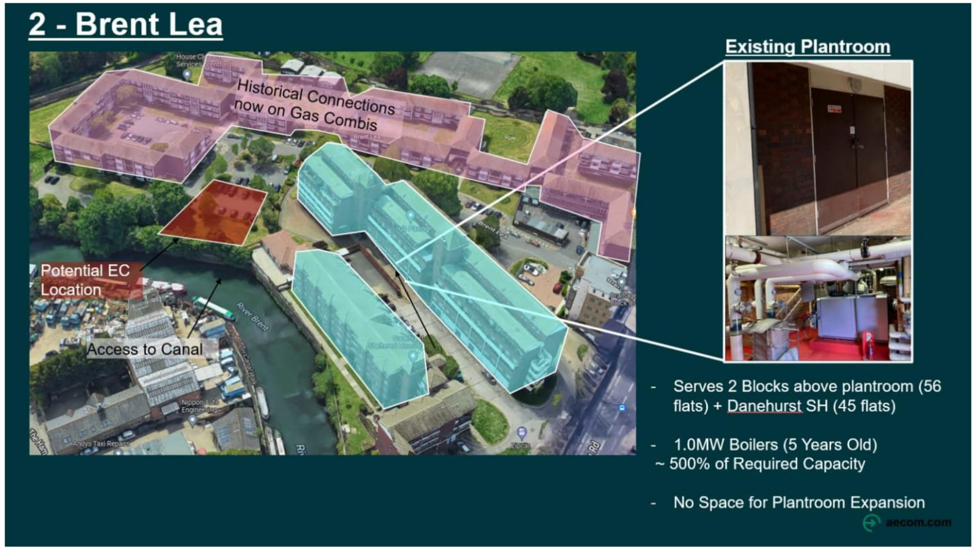
Table 15-35: NOx Emissions from Existing Systems and Proposed Network

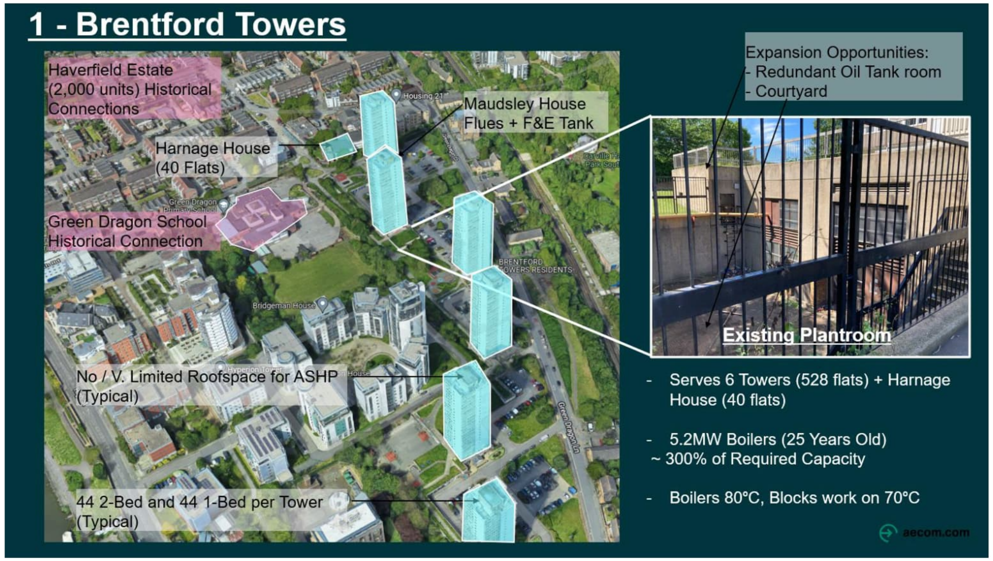
[94] Values used within the technoeconomic analysis in this study
[95] Assumed blended emissions rate from existing boilers of various ages in the buildings proposed for connection
[96] Based on Hoval Ultragas 2300D Manufacturers Technical Information

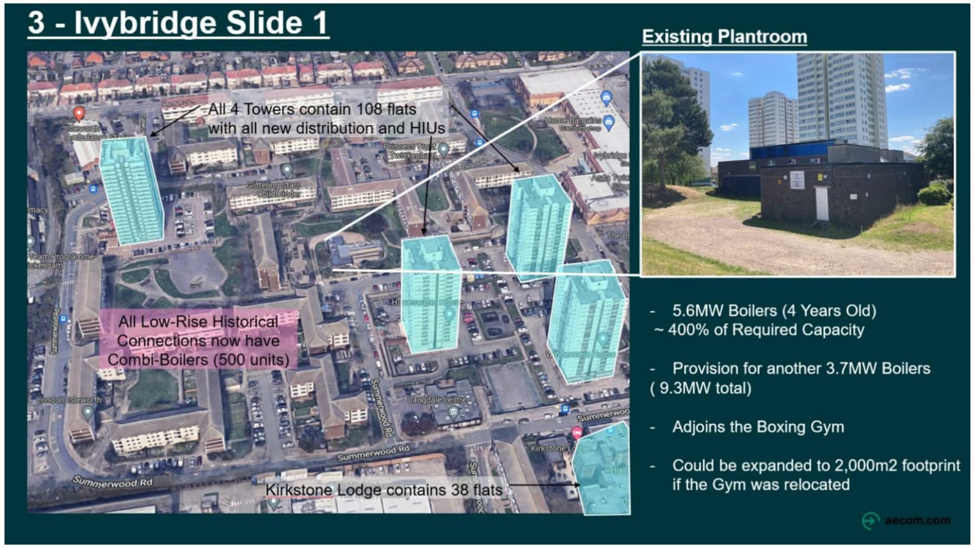
Appendix N – Surveys

AECOM conducted several surveys of anchor loads, existing plant rooms and potential energy centres to collect data and guide the proposed design.









3 – Ivybridge Slide 2

Existing Basement

- Circa 10,000m2 x 2.25m H
- Too low for Energy Centre
- Contains distribution to Towers
- Flooding issues?

aecom.com

5 – Redwood Estate

Typical Existing Plantroom

- 5 Existing Plantrooms serving most of the Blocks
- Estimated 20-30 low rise units contain combi boilers
- 4 plantrooms are 360kW, 1 is 620kW. All boilers installed in 2018

aecom.com

4 – Convent Way

aecom.com

Appendix O – Modelling Assumptions

O.1 Modelling Timing Assumptions

- Year 1 for all models is 2028. This is based upon Appendix Q – Project Programme and is the earliest foreseen heat on date considering deliverability constraints.
- Each individual cluster has been modelled in isolation with the assumption that construction resource is not to be shared across multiple networks. Therefore, linear buildout the distribution system enables access to all loads within each cluster in Year 1 of individual networks, however, for the complete borough solution construction is phased across three years, 2028, 2029, 2030, to reflect the scale of the network and shared resource. It is assumed all load for each year comes online simultaneously on day 1, this assumption leads to step changes in the energy demand which in practice would be more gradual as the network is built out.

O.2 Modelling CapEx Assumptions

The CapEx cost is the cost to be incurred by the developer/sponsor of the district heat network. Grant funding is not assessed at this point in time. The CapEx made allowances for contractor prelims, contractor overheads and profit, project design fees, Risk and Contingency. This covers a large amount of the external costs of developing a project, but there is an internal resource costs to the developer not captured here.

CapEx was calculated by breaking costs down into building costs, thermal generation costs, utility costs, network distribution costs, and project management and on-costs. These subsections of the cost plan can be broken down into individual line item. Each item was costed depending on the quantity required (e.g. meters of pipework, square meters of plant space, or kW of plant capacity). These were multiplied by a cost metric which is either:

- Static and does not vary with amount required (fixed cost per kW required).
- Dynamic and varies using a $y=aX^b$ relationship where:
  - Y is the cost per unit
  - X is the volume required
  - a & b are constants

These cost metrics are based off AECOM's in-house database. (Variable cost per kW required)

Key assumptions which impact the calculated CapEx:

- No allowances for secondary systems have been made within the scope of this project. This would include secondary pipework (within a block of flats for example) and customer Heat Interface Units (HIU's). Some social housing loads without communal systems have been included with individual dwelling connections included in the project costs.

Dig Type	Cost Metric (£/m)
Soft dig/closed site to building connections	
Sub Urban dig to building connections	
Urban dig to building connections	
Extra urban dig to building connections	
Specialist Crossing to building connections	

Table 15-36: Dig Cost Metrics

[97] BEIS Green Book

O.3 Modelling Asset Replacement Cycle Assumptions

The below table presents the proposed lifetimes for different plant items before replacement costs are incurred.

Technology/asset	Replacement cycle	Source
EC boilers, incl. ancillary equipment		
Heat pumps		
HIUs & internal distribution systems		
Heat exchangers		
Heat distribution pipework & civils works		

Table 15-37: Replacement cycle assumptions

O.4 Modelling OpEx Assumptions

BEIS Green Book Long Run utility price forecast was used in this study to estimate utility costs (see below figure). These are not reflective of current market rates as described in section 4.1.

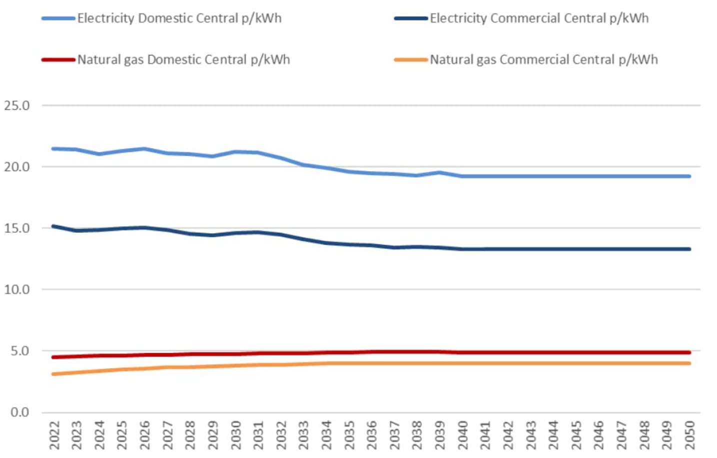


Figure 15-16: Graph of green book projected electricity and gas prices up to 2050[97]

Maintenance costs were included using a similar methodology to the CapEx costs with costs being calculated on a dynamic or static basis per number, kW or meters installed. See client issued TEM for details.

O.5 Tariff assumptions

Tariffs for this project are set equal to the GHNF aligned counterfactual cost in the base case.

O.6 Modelling Carbon Emission Assumptions

BEIS long run marginal forecast is used for this study.

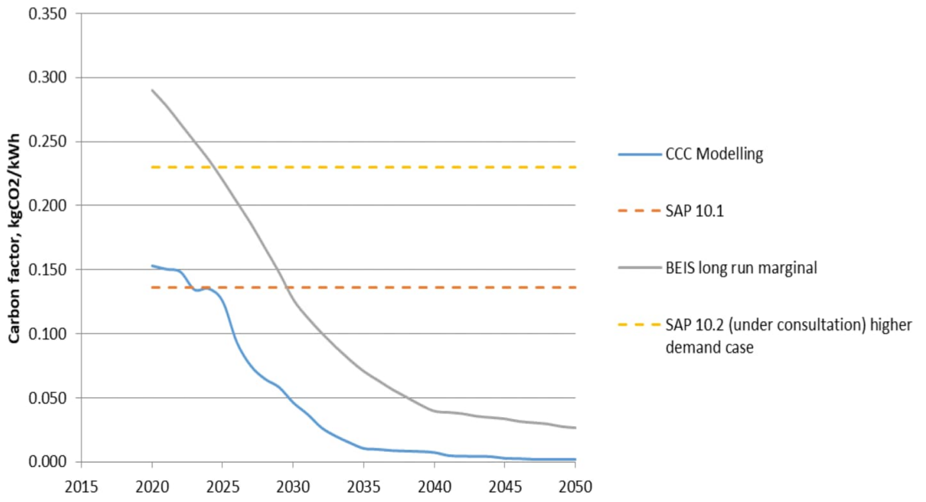


Figure 15-17: Graph of carbon factors up to 2050

O.7 Modelling Discount Rates

Discount rates are used to represent the future value of money spent now. In the UK, the government makes decisions based on 'discounted Net Present Value (NPV)', which is a calculation that helps inform whether a capital outlay made today will be worthwhile in the future. The model assumes a constant discount rate over the life of the network of 3.5%[98].

O.8 Financing Options

The model does not consider at this stage the impact of financing (e.g. the cost of raising finance, servicing debt, debt limits, types of credit etc.). The next stage of this study will advance the modelling of a chosen network option, accounting for these elements.

O.9 Tax

VAT is not included in the model as it only has a small impact on the cashflow due to the short construction period. Since this overlaps with operation it is not expected to impact the feasibility of the project.

O.10 Counterfactual Costs

The Assumed counterfactual costs used in modelling are as below. BEIS Green Book Price Factors are used for counterfactual analysis also. Communal plant has a lifetime of 20 years and domestic plant has a lifetime of 12 years (gas boiler) & 15 years (ASHP).

Plant size	Gas Boilers, 75°	Air Source Heat Pump, 55°	Air Source Heat Pump, 75°
50			
100			
200			
500			
750			
1000			
2000			
5000			
10000			

Table 15-38: Counterfactual CapEx £/kW vs Plant Size

Plant size	Gas Boilers, 75°	Air Source Heat Pump, 55°	Air Source Heat Pump, 75°
50			
100			
200			
500			
750			
1000			
2000			
5000			
10000			

Table 15-39: Counterfactual OpEx £/kW vs Plant Size

[98] Based on values taken from https://data.gov.uk/sib_knowledge_box/discount-rates-and-net-present-value,

Appendix P – CP1 Checklist & Statement of Applicability

Please refer to Hounslow HMMP_CP1 Checklist and Hounslow HMMP_CP1 Statement of Applicability issued as an accompaniment to this report.

Project Sheet

To record overall project and assessment details

Project name	
Hounlow (Heat Network) Heat Mapping and Masterplanning Study	
Client details	
Client name:	
Client email:	
Client telephone number:	
Client organisation:	London Borough of Hounslow
Project manager / lead engineer	
Name:	
email:	
Telephone number:	
Organisation:	AECOM Infrastructure and Environment
Assessor details (if appointed)	
Assessor name:	None at Current Stage (Stage 1)
Assessor email:	-
Assessor telephone number:	-
Document information	
An electronic master is be kept at:	London Borough of Hounslow
Current version number:	01
Last modified:	10/08/2022
Responsibility of:	London Borough of Hounslow
Signed:	

Other main contacts

Role	Name/organisation	email	Telephone
e.g. Feasibility consultant			
e.g. Designer			

Contents

CP1 STAGE 1: Preparation and briefing
CHECKLIST

– Use the drop-down to colour code columns D–G as per the key
– Add risk level and mitigation into columns G and H
– Include changes/explanation for variance/exceptions in column I

OBJECTIVE		KEY OUTPUTS	CP1 output developed?	Included in evidence	Output signed off?	RISK level	Risk mitigation	Change / Reason for variance / Exception
1.1	To commission the project in accordance with the Code of Practice	Output 1.1a – Project brief/specification for the project	YES	YES	YES	LOW		
		Output 1.1b – Client plan for monitoring progress and initial inputs into the evidence pack	YES	NO	YES	MEDIUM	Monitor progress and performance CP1 outputs at the completion of each stage	
		Output 1.1c – Team roles, responsibilities and qualifications log	YES	YES	YES	LOW		
1.2	To develop contracts that are fair and equitable for customers	Output 1.2a – Proposed service level plan in line with the Heat Trust requirements	YES	NO	YES	MEDIUM	Service level plan not included however level of service shall be in line with the Heat Trust requirements and the anticipated regulation of Heat Network Zoning / Energy Security Bill	
		Output 1.2b – Heat, cooling and power sales proposed contracts	YES	NO	YES	LOW	Proposed contracts not generated at this stage however to align with the performance standards of the Heat Trust requirements	
		Output 1.2c – Target heat price	YES	YES	YES	LOW		
		Output 1.2d – Intention to join Heat Trust or equivalent customer protection scheme	YES	NO	YES	LOW	Client intention to join the Heat Trust not included however level of service in line with the Heat Trust requirements and the anticipated regulation of Heat Network Zoning / Energy Security Bill	
1.3	To define appropriate service levels for the heat supply	Output 1.3a – Proposed heat supply service levels	YES	YES	YES	LOW		
		Output 1.3b – Proposed metering and monitoring arrangements	YES	NO	YES	LOW	Detailed metering and monitoring plan not developed, however design proposes meters at hydraulic breaks between primary network and secondary, either thermal substations or HIUs.	
1.4	To develop a detailed CP1 monitoring plan and feasibility study brief	Output 1.4a – A detailed CP1 monitoring plan	YES	NO	YES	LOW	Monitor progress and performance CP1 outputs at the completion of each stage	
		Output 1.4b – Statement of Applicability	YES	YES	YES	LOW		
		Output 1.4c – Feasibility study brief	YES	NO	YES	LOW	Feasibility study brief not developed at the time of completion of Stage 1 (HMMP)	

STAGE 1: Preparation and briefing
PERFORMANCE AIMS/TARGETS

		Initial aims	Estimated and included in evidence	Output signed off?	RISK level	Risk mitigation	Change / Reason for variance / Exception
ECONOMIC VIABILITY Cost of heat delivered (annual average all inclusive p/kW·h)	ENERGY CENTRE – Average variable cost (p/kW·h)	5.6p/kWh	YES	YES	HIGH	Cost uses BEIS Green Book projections of fuel prices which are lower than current market rates and if market rates at the time of operation remain higher then the stated target cost would also be higher. Liaison with BEIS to be undertaken to confirm the use of fuel prices	
	ENERGY CENTRE – Average fixed cost (£/yr)	£30/kWpeak/year	YES	YES	LOW		Stated as cost / kW of peak output from the energy centre given the variation of scenarios at this stage
	BUILDING/BLOCK (additional to energy centre) – Average variable cost (p/kW·h) [block by block if different]	11.5p/kWh total tariff (fixed + variable)	YES	YES	LOW		
	BUILDING/BLOCK (additional to energy centre) – Average fixed cost (£/yr) [block by block if different]	Included in above stated total tariff	YES	YES	LOW		
	DWELLING – Average variable cost (p/kW·h)	5.2p/kWh total tariff (fixed + variable)	YES	YES	MEDIUM	This level of tariff aligns with Heat Trust and GHNF requirements to provide a cost of heat to at risk customers that is no greater than a gas counterfactual, however, uses BEIS Green Book projections of fuel prices which are lower than market rates and thus the domestic tariff is estimated to be circa 27% of todays rates, and circa 40% of 2010's	
	DWELLING – Average fixed cost (£/dwelling/yr)	Included in above stated total tariff	YES	YES	MEDIUM	As above	
ENERGY CENTRE EFFICIENCY (% annual average all inclusive)	ENERGY CENTRE PLANT EFFICIENCY (%) of each plant item, e.g. LZC1, LZC2, boilers etc.	WSHP: >270% Gas Boiler: >90%	YES	YES	LOW		
NETWORK HEAT LOSSES (annual average kW·h/yr)	ENERGY CENTRE – Primary heat network loss (kW·h/yr)	< 10% of heat supplied from the energy centre	YES	YES	LOW		
	BUILDING/BLOCK – Average primary summer return temperature at the building/block (°C)	40°C	YES	YES	LOW		
	BUILDING/BLOCK – Average primary winter return temperature at the building/block (°C)	50°C	YES	YES	LOW		
	BUILDING/BLOCK – Secondary heat network loss (kW·h/dwelling/yr)	876.0	YES	YES	HIGH	The majority of secondary side networks are existing and therefore outside of the control of the network scope at present. At Feasibility stage, a separate feasibility study should be undertaken to assess and improve the efficiency of secondary networks of loads proposed to be connected to the network	
	DWELLING – HIU average return temperature based on HIU performance and space heating design and set-up (°C)	45°C	YES	YES	LOW		
	DWELLING – HIU standby heat losses (W)	1kWh/day	YES	YES	LOW		
	DWELLING – Time to deliver 45 °C to the kitchen tap (seconds)	< 45 seconds	YES	YES	LOW		
ENVIRONMENTAL Carbon intensity of heat (annual average all inclusive $kgCO_2$/kW·h heat)	ENERGY CENTRE – $kgCO_2$/kW·h heat (annual average all inclusive)	< 0.1kgCO2e/kWh in first year of heat on	YES	YES	MEDIUM	Availability of low grade heat from ground aquifer may be less than required to generate heta at this carbon intensity of the proposed network extent. In this case, the network extent should be reduced or a supplementary low carbon technology added, or both until the goal intensity is achieved	

STAGE 1: Preparation and briefing
SIGN-OFF

			STAGE 1 fully signed off?	Date both fully signed off	KEY Risk mitigation actions	KEY Changes / Reason for variance / Exception
Have all the CP1 outputs been produced for STAGE 1?	Client signature	Damien McCaul				
Have all the agreed performance targets been set for STAGE 1?	Client signature	Damien McCaul				
Have the STAGE 1 outputs/targets been included in the evidence pack?	Client signature	Damien McCaul				
Has the level of risk been allocated to the STAGE 1 outputs/targets?	Client signature	Damien McCaul				

Objective		Main responsibility: Developer/Owner	Designer	Constructor	Operator		Minimum Requirements	Applicability	Notes
Preparation and Briefing									
1.1	Commission the project in accordance with the Code of Practice					1.1.1	Code of Practice key requirement	Yes	
						1.1.2	Monitor implementation	Yes	
						1.1.3	Develop clear specification	Yes	
						1.1.4	Monitor predicted and actual performance	Yes	
						1.1.5	Evidence pack signed off at each stage	Yes	
						1.1.6	Effective handover	Yes	
						1.1.7	Feedback to CIBSE	Yes	
						1.1.8	Suitably qualified and experienced people	Yes	
						1.1.9	BSRIA Design Framework	Yes	
						1.1.10	Elements of the Code of Practice not to be included	Yes	
						1.1.11	Existing heat network operator advice on new connections	No	There is no existing heat network operator
						1.1.12	Client to outline appropriate level of risk	Yes	
1.2	To develop contracts that are fair and equitable with customers					1.2.1	Client to set out target costs and charging structure	Yes	Target costs determined with a target of being no worse than a gas boiler or existing system alternative for domestic and micro-business customers (i.e. customers at risk) and no worse than the low carbon alternative for all other customers.
						1.2.2	Heat Trust scheme	Yes	The introduction of the Energy Security Bill may provide regulatory standards for the network
						1.2.3	Service standards in-line with heat trust scheme	Yes	
						1.2.4	Non-domestic contracts	Yes	
						1.2.5	Billing information provided to residents	Yes	
						1.2.6	Target level for availability of heat	Yes	
						1.2.7	Compensation	Yes	In line with Heat Trust requirements
						1.2.8	Response time	Yes	In line with Heat Trust requirements
						1.2.9	Vulnerable customers	Yes	In line with Heat Trust requirements
						1.2.10	Alternative heating source	Yes	
						1.2.11	Potential customers to be provided with information	Yes	
						1.2.12	Proposed contract to include details on plant replacement, and ownership and maintainance parties	Yes	
1.3	To define appropriate service levels for the heat supply					1.3.1	Define design external air temperature	Yes	
						1.3.2	Maximum heat supply capacity for each customer.	Yes	
						1.3.3	Establish type of DHW and SH systems and operating temps	Yes	Given the number of customers, it is assumed that a mix of DHW and SH systems will be present. Surveys to be undertaken of all existing buildings to establish the temperature requirement at each site prior to connection. Until known, the network temperature shall be determined to satisfy the requirement of the worst case proposed connection.
						1.3.4	Summer period flow temperature	Yes	
						1.3.5	Variations in flow temperature to be defined	Yes	
						1.3.6	Periods when supply of space heating is shut down	No	It is not envisaged that separate space heat and domestic hot water systems would be established to enable summer shut down of SH. This would be controlled by the customer side systems.
						1.3.7	Operating hours of the network	No	It is not envisaged that the heat network will operate intermittently.
						1.3.8	Location and access to the heat supply meter	Yes	
						1.3.9	Monitoring heat supply to customers	Yes	
						1.3.10	Frequency and type of maintenace visits	Yes	
						1.3.11	Clearly define demarcation between heat supplier system and customer	Yes	At the hydraulic break either substation or HIU. Direct connections are not envisaged, however if some are included, the demarcation point will be made clear e.g. a point of entry isolation valve.
						1.3.12	Technical aspects of heat supply contract reviewed at each design stage	Yes	
1.4	To develop a detailed CP1 monitoring plan and feasibility study brief					1.4.1	Client and advisors to agree CP1 monitoring plan.	Yes	Reviewed in CP1 tracker at each design stage
						1.4.2	Must include 'Statement of Applicability'	Yes	
						1.4.3	Client to develop a brief for Stage 2 feasibility study	Yes	
Feasibility									
2.1	To achieve sufficient accuracy of peak heat demands and annual heat consumptions					2.1.1	Existing and new buildings - demands based on highest frequency data available	Yes	Where data is available to the designer
						2.1.2	Demands if consumption data not available	Yes	Benchmarks from similar building use types shall take priority over TM54 data where available
						2.1.3	Temporary monitoring of existing buildings with atypical heat loads	Yes	Where agreed by building owners
						2.1.4	Heat consumption demand for new buildings to use modelling software	Yes	
						2.1.5	Estimate end use and losses	Yes	
						2.1.6	Space heating degree day analysis	No	The effect of local weather shall be included in the analysis, however this does not necessarily need to be via degree day analysis. For example, historic half hourly metered data could be used instead.
						2.1.7	Occupancy patterns	No	This should be superseded by accurate demand profiles
						2.1.8	Future heat demand	Yes	
						2.1.9	Assessment of the potential stakeholders	Yes	
						2.1.10	Data on potential connections to be recorded in evidence pack	Yes	
2.2	To identify the most suitable low carbon heat sources and location of an energy centre					2.2.1	Energy masterplan shall be developed	Yes	
						2.2.2	Available heat sources and technologies	Yes	
						2.2.3	Whole life costs and CO_2 emissions	Yes	Embodied carbon assessment of the network should also be be considered
						2.2.4	Environmental impact	Yes	
						2.2.5	Mixture of heat sources	Yes	
						2.2.6	Suitable energy centre locations	Yes	
						2.2.7	Financial incentives	Yes	
						2.2.8	Operating model - heat source sizing	Yes	
						2.2.9	Operating model - thermal stores and efficiency of plant	Yes	
						2.2.10	Operating model - hour by hour approach	Yes	
						2.2.11	CHPs electricity export requirements	No	Fossil fuelled CHP no longer considered compliant with low carbon networks
						2.2.12	Operating model used to optimise heat network	Yes	
						2.2.13	Future potential assessment	Yes	
2.3	To determine the location of top-up and standby boilers and use of existing boilers					2.3.1	Heat customer discussions	Yes	
						2.3.2	Centralised/distributed boilers and consider decentralised in new developments	Yes	The network shall endeavour to reuse existing gas boilers in London Borough of Hounslow owned sites which are proposed to connect to the network

						2.3.3	Hydraulic control	Yes	
						2.3.4	Space requirements	Yes	
2.4	To select suitable operating temperatures					2.4.1	Existing secondary system temperatures	Yes	
						2.4.2	Suitable heat source operating temperatures	Yes	
						2.4.3	Flow temperature reduction	Yes	
						2.4.4	Temperature differential	Yes	
						2.4.5	Higher flow temperature/thermal store	Yes	
						2.4.6	Hydraulic separation	Yes	
						2.4.7	Legionella	Yes	
						2.4.8	Instantaneous HIU setpoint 50	Yes	
						2.4.9	Maximum temperatures for poylmer pipes	Yes	Polymer pipes shall only be considered where a guarantee that they will achieve the same lifespan as the steel alternative when operating at the proposed network temperature and pressure is provided and approved by the clieant and their design team.
						2.4.10	Space heating and Domestic Hot Water operating temperatures	Yes	This shall also apply to supplementary systems i.e. not full replacement
						2.4.11	Rebalancing existing radiator circuits	Yes	
						2.4.12	Heat exchanger approach temperatures	Yes	Heat exchangers to be selected at a 50%/50% basis unless otherwise requested by the customer
						2.4.13	Control systems in existing buildings	Yes	
2.5	To define heat network distribution routes, pipe sizes and costs					2.5.1	Minimise network length	Yes	Network length to be optimised rather than minimised, considering all aspects
						2.5.2	Heat network routes integrated with other utility routes	Yes	
						2.5.3	Service areas within networked buildings	Yes	
						2.5.4	Major barriers	Yes	
						2.5.5	Existing utilities review	Yes	
						2.5.6	Pipe route constraints	Yes	
						2.5.7	Third party wayleaves	Yes	The use of third party land shall be avoided where possible
						2.5.8	Highways Department discussions	Yes	
						2.5.9	Pipe sizing calculations	Yes	
						2.5.10	Insulation thickness	Yes	
2.6	To determine building connection costs including heat metering					2.6.1	Direct/indirect connections	Yes	Indirect shall be assumed as a worst case and revised in later stages
						2.6.2	Cost-benefit analysis of various DHW service types	Yes	
						2.6.3	Cost estimates	Yes	
						2.6.4	Building connection capacity	Yes	
						2.6.5	Costs for building level metering	Yes	
						2.6.6	Retrofitting dwelling metering in existing buildings	Yes	
						2.6.7	Metering and billing	Yes	To be considered at Stage 3 in detail.
						2.6.8	New and extended heat networks to use AMR	Yes	To be considered at Stage 3 in detail.
						2.6.9	Location and maintenance of HIUs (external HIUs more accessible)	Yes	To be considered at Stage 3 in detail.
						2.6.10	HIU remote monitoring and control	Yes	To be considered at Stage 3 in detail.
2.7	To minimise the negative impacts of phasing the development					2.7.1	Phasing plan	Yes	
						2.7.2	Pipe sizing provision for future expansion	Yes	Strategy to be agreed at later stages. Conservatively should be based on the maximum generation capacity in main spines rather than demand
						2.7.3	Low-carbon technology phasing	No	
						2.7.4	Long term operational efficiency	Yes	
						2.7.5	Energy centre location	Yes	
						2.7.6	Cost penalty	No	
2.8	To assess lifecycle operation, maintenance and replacement requirements, costs and revenues					2.8.1	Economic modelling of operational costs	Yes	
						2.8.2	Maintenance costs	Yes	
						2.8.3	Metering and billing costs	Yes	
						2.8.4	Other costs	No	To be considered in the financial modelling at Outline Business Case, typically post Stage 2
						2.8.5	Parasitic electricity consumption	Yes	The electricity consumption by circulation pumps shall be accurately modelled rather than relying on an estimated percentage. For river abstraction systems for example, pumping energy can represent 10% of the heat moved.
						2.8.6	Long term repair and replacement strategy	Yes	Demonstrated on Energy Centre general arrangement drawings rather than strategy document at this stage
2.9	To conduct a consistent economic analysis and options appraisal					2.9.1	Economic analysis conducted in accordance with clients requirements	Yes	
						2.9.2	Discounted cashflow model	Yes	
						2.9.3	Period of analysis	Yes	
						2.9.4	Energy prices	Yes	Where projected prices are used, a comparison between current market values shall also be included for context
						2.9.5	Heat sales	Yes	The counterfactual shall not necessarily be the existing system. Where the existing system does not offer a competitive carbon intensity, a low carbon counterfactual shall be developed and agreed with the client. The exception to this shall be customers at risk.
						2.9.6	Capital cost model	Yes	
						2.9.7	Retrofit energy efficiency measures	Yes	Care must be taken to ensure these costs are not included in an application for grant support, where they are specifically excluded by the scheme.
						2.9.8	Discount rate	Yes	
						2.9.9	IRR and NPV	Yes	
						2.9.10	Sensitivity analysis	Yes	
2.10	To analyse risks and carry out a sensitivity analysis					2.10.1	Risk register	Yes	
						2.10.2	Likelyhood and severity of risks	Yes	
						2.10.3	Mitigation assignment	Yes	
						2.10.4	Suitable contingencies included in OPEX and CAPEX model	Yes	Costed risk register to be created at later stages. A risk % is applied at Stage 2
						2.10.5	Major risk impact assessment	Yes	
2.11	To assess environmental impacts and benefits					2.11.1	CO2 emissions calculations	Yes	
						2.11.2	Heat losses and electricity use	Yes	
						2.11.3	NOx and particulate emissions	Yes	
						2.11.4	Environmental impact of biofuels	Yes	
						2.11.5	Emission requirements for gas-fired CHP	No	Fossil fuelled CHP no longer considered compliant with low carbon networks
						2.11.6	Heat pump refrigerants chosed to minimise GWP, and leakage rate-based assessment should be carried out	Yes	Natural refrigerants shall be prioritised.
						2.11.7	Acoustic impact	Yes	
						2.11.8	Visual impact	Yes	
						2.11.9	Pre-application discussions with local planning authority	Yes	
2.12	To develop a comprehensive feasibility study report					2.12.1	Feasibility study report content	Yes	
						2.12.2	Statement of Applicability' to be updated	Yes	
						2.12.3	Gantt chart to show stages, timescales and milestones	Yes	A delivery schedule will typically be suffient, not necessarily a Gantt Chart.

						2.12.4	Develop a risk register	Yes	
2.13	To develop preferred business structures, contract strategy and procurement strategy					2.13.1	Client to appoint financial, legal and project management experts	No	To be undertaken at later design stages, during DPD
						2.13.2	Advisors to collaborate	No	To be undertaken at later design stages, during DPD
						2.13.3	Client to ensure suitable resource availlable	No	To be undertaken at later design stages, during DPD
						2.13.4	Finance, risk, governance and exit strategy	No	To be undertaken at later design stages, during DPD
						2.13.5	Procurement strategy	No	To be undertaken at later design stages, during DPD
Design									

Appendix Q – Project Programme

AECOM has developed an initial project programme with risk adjusted contingency for each stage (white blocks). This should be used as a guide to support LBH planning the timeline for decarbonisation across the borough.

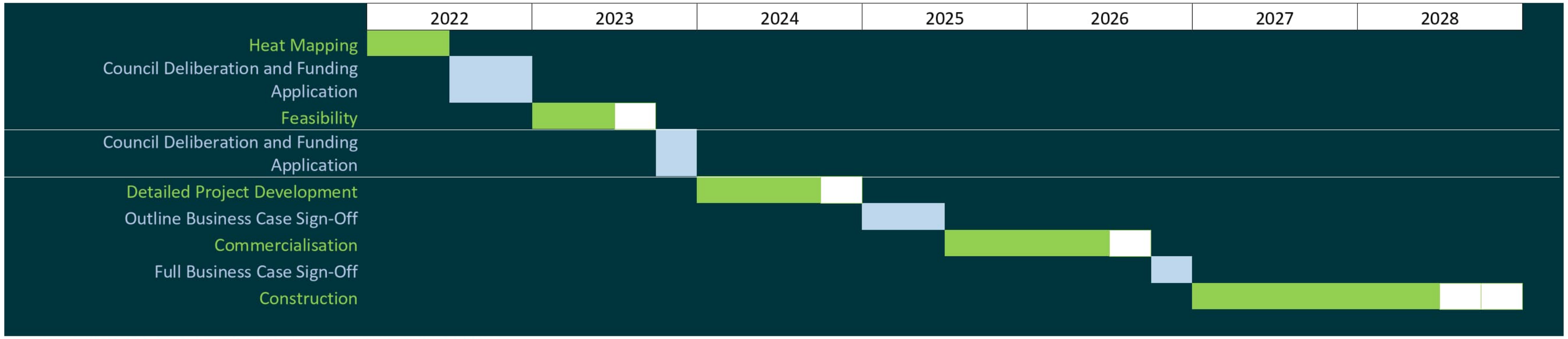


Table 15-40: High Level Project Programme for an individual cluster

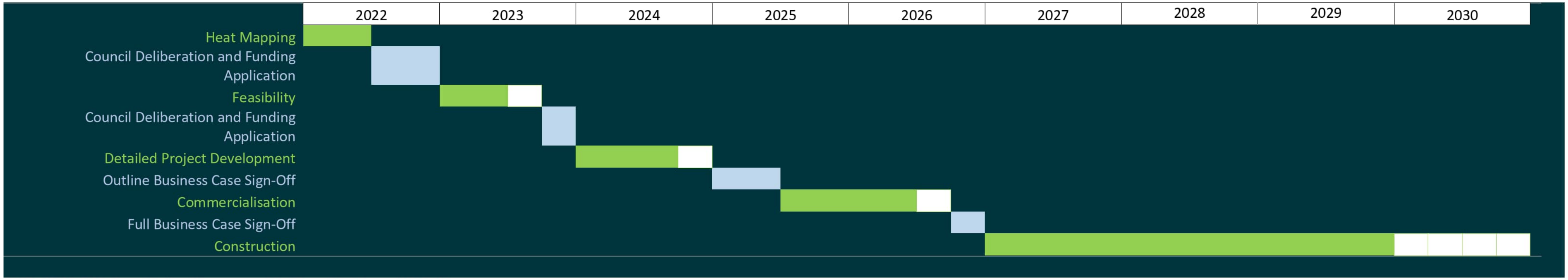


Table 15-41: High Level Project Programme for Complete Borough Solution

Appendix R – Risks, Assumptions & Opportunities Log

Please refer to Hounslow HMMP Risks, Assumptions & Opportunities Log issued as an accompaniment to this report

Key

Enter Details

Risk, Assumptions, and Opportunities Register	
Project Name	Hounslow
Project Stage	HMMP
Project Location	London Borough of Hounslow
Author(s)	JG
Date	Mar-22
Revision	1

Version Control

Revision History	Date	User	Approver	Project Stage
1	Aug-22	JG		HMMP

PROJECT RISK REGISTER

LA Name:	Hounslow HMMP
Opportunity Name:	Hounslow DEN
Latest update:	29/08/2022
Previous update:	08/07/2022

Risk Identification					Risk Assessment				Mitigation & Action			
Risk No.	Risk Rank	Risk Category	Risk Title	Risk description (Incl.potential impact on cost and schedule)	Impact (low 1- high 5)	Likelihood (low 1- high 5)	Current Risk Rating *(auto-calc)*	Proximity *(<1-month - Imminent, 1-6months - Soon , 6-18months Later, 18-36 months Future, <36 Ongoing)*	Proposed Mitigation	Post Mitigation Impact (low 1- high 5)	Post Mitigation Likelihood (low 1- high 5)	Post Mitigation Risk Rating *(auto-calc)*
1	2	Technical - Other Design								5	2	10
2	35	Technical - Other Design								3	1	3
3	5	Technical - Other Design	Ground borehole yields	The groundwater yields that can be obtained from boreholes is not sufficient to supply the LZC plant capacity required to achieve the network carbon intensity	4	4	16	Later	Carry out bore hole pilot testing in proposed locations. Select an alternative LZC depedant on bore hole testing results not dependant on aquifer yield.	2	4	8
4	11	Technical - Other Design	Borehole locations	Where boreholes are not installed on council land, suitable agreements for the use of privately owned land cannot be obtained	4	3	12	Soon	Do not specify bore holes on private land.	1	1	1
5	36	Technical - Other Design								5	1	5
6	12	Technical - Customer & Demands	Lack of heat customers	A sufficient number of identified buildings do not wish to connect to the network, and replacement customers cannot be identified, reducing network revenue and potential making it unviable	4	3	12	Soon	Enhanced private stakeholder engagement to derisk. Maintain log of proposed private connections and likelihood to connect. Inform prospective customers of heat network zoning to encourage active engagement.	4	2	8
7	37	Technical - Other Design								2	1	2
8	38	Technical - Other Design								2	1	2
9	23	Technical - Customer & Demands	Estimated demand	The benchmarked demand estimates for customer buildings are inaccurate leading to inaccurate modelling of the financial viability	3	3	9	Later	Increase the average data quality score from 52.5% to 70% at feasibility by collecting a large proportion of stakeholder metered data	2	2	4
10	6	Economic Case	Grant funding	Grant funding - Green Heat Network Funding (GHNF) criteria & programme - scheme doesn't obtain sufficient funding to become an attractive investment	4	4	16	Later	Optimise the scheme to deliver an unfunded IRR of 6% to reduce the grant size required and increase the likelihood funding will be obtained	2	2	4
11	7	Technical - EC Design	Land ownership	Where energy centres are not located on council owned land, agreements cannot be obtained for the lease or purchase of the land/space	4	4	16	Later	Do not specify EC's on private land	1	1	1
12	13	Technical - Other Design	Planning permission	Planning permission is not obtained for newly constructed energy centres,	4	3	12	Later	Scope for planning consultant to review design and application to derisk rejection	4	2	8
13	24	Technical - Customer & Demands	Existing heating systems	Existing heating systems are not suitable for connection to a DH scheme and are not willing to carry out the necessary modifications to make them compatible	3	3	9	Later	Enagage with loads that are not compatible and wouldn't be mandated under heat network zoning. Provide technical support if that is the barrier. Negotiate connection fee and tariff if cost is the barrier.	1	2	2
14	29	Technical - Customer & Demands	Public response	Negative public reception due to roadworks in busy areas of the town.	2	4	8	Later	Engage with national highways to minimise impact of road works including using alternaitve routes and scheduling construction to prevent traffic. Provide public announcments to give sufficient warning alternative routes	2	3	6
15	25	Technical - Customer & Demands	Reduction in demand	Customer buildings undertaken demand reduction works in the future which reduce network revenie	3	3	9	Later	During RIBA 0-4: Assess loads individually to determine possible future works and adjust demand modelling accordingly. During RIBA 7: Propose study to expand network to small loads to counteract demand reduction.	2	2	4
16	14	Technical - EC Design	Electrical supply	Electrical DNO are unable to provide an electrical supply to energy centres at a cost that could be paid by the project and remaining economically viable	4	3	12	Later	Explore alternative electrical supply options such as renewable onsite generation and storage. Contract electrcial connection consultant to assess alternative grid connection point and reinforcements.	3	2	6
17	39	Technical - EC Design	Gas supply	Gas DNO are unable to provide a gas supply to energy centres at a cost that could be paid by the project and remaining economically viable	4	1	4	Later	Assess the use of bio-gas from Mogden sewage works.	3	1	3
18	15	Technical - Customer & Demands	Heat on dates	Heat on date for network does not arrive sufficiently quickly for customers and they implement their own low carbon heating solution and do not need connection to heat network.	3	4	12	Later	Assess every loads required heat on date and design phasing to maximise connections. Provide temporary plant to meet remaining heat-on requirments. Consider enabling prosumers to connect.	2	2	4
19	3	Commercial Case								2	1	2
20	9	Economic Case	Heat Network Regulation	Future government regulations / Ofgem regulations regarding heat networks could limit heat costs, affecting the profitability of the scheme.	5	3	15	Later	Model using BEIS recommended methodology and metrics.	2	1	2
21	30	Technical - Other Design	Environment Agency Licensing	Licensing is not obtained from the EA for open loop borehole or river water heat recovery	4	2	8	Later	Follow EA guidelines throughout design.	4	1	4
22	16	Technical - EC Design	Boiler flues	Boiler flues at energy centre sites cannot be discharged in a compliant manner	4	3	12	Later	Explore alternative electrcially powered resilient plant.	2	3	6
23	4	Economic Case	Capital cost estimates	Assumed market costs in modelling may not accurately reflect future costs due to unforseen and challenging market conditions	5	4	20	Later	Conduct HNDU spec sensitivity analysis increasing CAPEX to assess impact, ensure scheme ability to continue with such conditions.	3	4	12
24	26	Economic Case	Fuel purchase prices	Fuel price inflation may lead to reduced margins	3	3	9	Later	Conduct HNDU spec sensitivity analysis increasing fuel price to assess impact, ensure scheme ability to continue with such conditions.	2	3	6
25	17	Technical - Network Design	Specialist crossings	Special crossings at major roads, railways and rivers lead to delays or signficant costs	3	4	12	Later	Conduct route proving surveys with key focus on specialist crossings, quantifiable measurements and assess itemised works required for each crossing.	3	2	6
26	10	Technical - Network Design	Existing utilities	Existing utilities are discovered along the planned network route and rerouting is required leading to delays or signficant costs	3	5	15	Later	Add substantial construction schedule contingency for network delivery portuion of works. Carry out C2 utility search (CAT scan of burried infrastructure.	2	3	6
27	40	Technical - Customer & Demands	Local plan changes	Changes to local plan remove priority for heat networks	3	1	3	Later	None required - National policy superceeds	3	1	3
28	32	Technical - Network Design	Archaeological remains	Archaeological remains are discovered along the planned network route and rerouting is required leading to delays or signficant costs	3	2	6	Later	Add substantial construction schedule contingency for network delivery portuion of works. Carry out C2 utility search (CAT scan of burried infrastructure.	2	1	2
29	33	Technical - Network Design	UXO	UXO are discovered along the planned network route leading to delays or signficant costs	3	2	6	Later	Add substantial construction schedule contingency for network delivery portuion of works. Carry out C2 utility search (CAT scan of burried infrastructure.	2	1	2
30	34	Technical - Network Design	Road closures	Approval for road closures along the planned network route not received leading to delays or signficant costs	3	2	6	Later	Apply earlier then required by policy.	3	1	3
31	18	Technical - Customer & Demands	Price of heat	Negative reception from potential customers due to an increase in the price of heat compared to gas systems, meaning they are reluctant to connect.	3	4	12	Later	Convey savings compared to decarbonised counteractual. Provide competitive tariff.	2	2	4
32	8	Technical - Customer & Demands	Fuel poverty	Low carbon heat, at a higher cost compared to natural gas, leads to an increase in customer fuel bills and results in fuel poverty	4	4	16	Soon	LBH to review financial aid for those in fuel poverty, prioritising fabric improvements over tariff subsidies.	3	3	9
33	21	Technical - Deliverability	Planning permission	Planning approval for the network is not obtained	5	2	10	Later	Engage with planning committee to gain support of councillors in advance of application.	5	1	5
34	19	Technical - EC Design	Ground conditions	Ground conditions at the energy centre site require a piled foundation which is costlier than the project can afford	4	3	12	Later	Assess ground conditions at early stage to derisk prefered EC sites.	4	1	4
35	27	Technical - Customer & Demands	Customer connection charges	Connection charges are subject to negotiation and may not match what has been included in the modelling risking delays in agreeing and signing off tariffs and connection charges	3	3	9	Later	Model connection fees conservatively.	3	2	6
36	22	Strategic Case	Client Support	Support for district energy within the council diminishes and there is no client to progress the project	5	2	10	Later	Engage prospective energy service companies (ESCo's) early to incoporate feedback into design and derisk lack of client. Maintain ambitious schedule upto OBC in order to retain momentum of support within council.	5	1	5
37	20	Economic Case	Newtwork expenditure	Optimism bias in cost plan may lead to underestimate of capital/replacement costs or other shifts in economy may lead to increased costs	4	3	12	Ongoing	Assess cost plan data against full spread of real world values.	3	2	6
38	28	Economic Case	Network revenue	Variable returns - economic modelling smooths out income (and expenditure) which will be affected by factors such as the weather	3	3	9	Ongoing	Engage financial modelling consultant to complete granular cashflow assessment	3	1	3
39	31	Technical - Deliverability	Resource availability	Limited availability of contractors due to growing number of district heating projects causing lack of resources	4	2	8	Later	Highlight risk to BEIS to influence national policy and support heat network upskilling.	3	1	3
40	1	Technical - EC Design	UKPN Capacity constraints	It is noted that west london is extremely constrained in terms of electrcity grid capacity. A ban on the building of new homes in the area is till 2035. As such a connection of the scale required may not be possible. Recent UKPN applications have been declined for this reason.	5	5	25	Soon	Explore alternative electrical supply options such as renewable onsite generation and storage. Contract electrcial connection consultant to assess alternative grid connection point and reinforcements.	4	3	12

PROJECT ASSUMPTION REGISTER

LA Name: *Hounslow HMMP*

Opportunity Name: *Hounslow DEN*

Latest update: *29/08/2022*

Previous update: *08/07/2022*

Assumption No.	Assumption Category	Assumption Title	Assumption description
1	Technical - Customer & Demands	Council Heat Pump Utilisation	It is assumed that the schools and lesiure centres with council installed heat pumps have a utilisation upto 68% of the maxmium output. i.e. a 100kW heat pump runs at maxmimum output 68% of the time or at 68kW constantly.
2	Technical - Customer & Demands	Council Heat Pump COP	it is assumed that the schools and lesiure centres with council installed heat pumps achieved a SCOP of 2.5.
3	Technical - Customer & Demands	Pre-Planning Site Allocation Developments Residential Dwelling GIA: single bed	its is assumed that single bed flat dwellings modelled from pre-planning site allocations have a GIA of 50m2 as per https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/725085/Floor_Space_in_English_Homes_main_report.pdf
4	Technical - Customer & Demands	Pre-Planning Site Allocation Developments Residential Dwelling GIA: General Dwelling	its is assumed that a general dwelling modelled from pre-planning site allocations have a GIA of 66.4m2. This is a blend of 80% multi-occupancy flats (60m2) and 20% any dwelling (92m2) as per https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/725085/Floor_Space_in_English_Homes_main_report.pdf
5	Technical - EC Design	Mogden Scale	
6	Economic Case	Mogden Cost of Heat	
7	Technical - EC Design	Mogden/Ivybridge EC Space	
8	Technical - EC Design	Ground source sufficient bore holes	For a ground source led EC a sufficient number of bore holes can be made to enable flow rate
9	Economic Case	LCoH to end user (resi and micro-business)	LCoH to end user (resi and micro-business) will not be higher than the exisiting cost with gas boiler BaU. Other customers/council will be willing to pay a higher tarrif to offset.
10	Technical - Cu		
11	Technical - Customer & Demands	Pre-plannning site allocations	Assume all pre-planning site allocations upto 2026 will be included in the network modelling and all after 2026 will be excluded.
12	Economic Case	Compatible secondary side	Assume all secondary side systems with no information are compatible and project doesn't absorb cost of retrofit
13			
14			
15	Technical - Customer & Demands	Council Heat Pump Methodology	Assume that the council retorfitted heat pumps in schools are done so in 2021/2022 i.e. after the 2019 stakeholder dataset used in demand profiling. Thus, heat demand and electrical demand has been adjusted to using assumoptions 1 and 2 accordingly.
16			
17			
18	Technical - Other Design	Customer flow temperatures	It is assumed that all exisiting buildings operate on a flow temperature of 80degC and all buildings under construction or planned operate at 60degC
19			
20			
21	Technical - Customer & Demands	Metered data	It is assumed that all metered data deemed to be poor quality (missing readings, negative readings) is not to be recorded and as such the benchmarked demand data takes precendent.

PROJECT OPPORTUNITY REGISTER

LA Name:	*Hounslow HMMP*
Opportunity Name:	*Hounslow DEN*
Latest update:	*29/08/2022*
Previous update:	*08/07/2022*

Identification				Assessment			
Opp No.	Opp Category	Opp Title	Opp description	Impact (low 1- high 5)	Likelihood (low 1- high 5)	Current Opp Rating *(auto-calc)*	Proximity (*<1-month - Imminent, 1-6months - Soon , 6-18months Later, 18-36 months Future, <36 Ongoing)*
1	Technical - Customer & Demands	Communal system secondary losses	opportunity to improve accuracy of benchmarking and metered data of communal loads by gaining understanding of secondary side and age to accurately determine losses and amend annnual demand accordingly	1	3	3	*Soon*
2	Technical - Customer & Demands	Heathrow Connection	Heathrow airport connection to be considered at feasibility stage. Initial estimates indicate demand would increase by x2 with this connection	4	3	12	*Soon*
3	Technical - Customer & Demands	Residential individual Gas Boiler Connection	Currently excluded resi/social housing loads could have secondary side works in order to connect.	3	1	3	*Later*
4	Technical - EC Design	Hounslow Town Centre Vehcile Depot Relocation	Hounslow Town Centre Vehcile Depot is slated for relocation to a new site. LBH is currently unaware of any plans for the current site. This provides an opportunity to redevelop the site with an energy centre and LZC such as air-source heat pump integrated into the design from the outset providing better final results compared to retrofit.	2	4	8	*Later*

Appendix S – Zero Carbon Route Map

The district heating network(s) proposed in this report are only a steppingstone to net zero carbon. Several further steps are needed to maximise the value of the network and address all building related emissions. The first priority in developing a net zero strategy is to maximise opportunities for demand reduction and energy efficiency. This hierarchy, illustrated in the diagram below, is crucial for developing a cost effective, socially responsible, and robust carbon management plan.[99]

S.1 Energy Demand Reduction

The lowest carbon energy is the energy that we do not use. LBH should carry out exercises activities for their estate and encourage private buildings within the borough to do the same. This is a continuous process and should be reviewed regularly even on buildings where other carbon saving initiatives have been established.

- Increase visibility of consumption through granular real-time metering and monitoring to identify issues.
- Commission energy audits and subsequent analysis work for each building to identify interventions.
- Implement effective and efficient controls. This could include a demand response control regime on the network such as to eliminate or shift demand from the time of peak network use to minimise utilisation of high carbon peaking plant and flatten the demand curve.

Possibly interventions and resulting emissions savings following energy audits have been described for an example London office building in the below diagram. Cumulatively, these interventions allowed the building to achieve net zero emissions. To reduce demand, all buildings should be upgraded to meet high energy performance standards, introduce efficient building services and appliances, and maximise on-site renewable energy generation. LBH has implemented or plans to implement measures including heat pump installation, building management system installs, LED lighting upgrades, solar PV installation, and battery storage at 27 corporate and 34 educational council owned buildings.

[99] Adapted from *'Figure 1: The Carbon Trust three stage approach to developing a robust carbon management strategy'* (2006).

Figure 15-18: Building CO2 emission reduction options

Buildings not suitable for connection to the district heat network should also be audited to following the above principles to realise the carbon benefit.

S.2 Network Efficiency

Following building level works, the proposed district heat network can undergo several improvements to reduce carbon.

S.2.1 Network Temperature

Reviewing district heat network operating temperatures to establish the minimum temperature required to achieve comfort levels within buildings enables the reduction of network flow temperature. Lowering network temperatures reduces thermal losses and improves network efficiency. This results in lower carbon emssions.

S.2.2 Degasification

31% of the proposed networks heat demand is supplied by Gas Boilers. This is because the low carbon electrically driven heat pump has been sized to the baseline demand. Heat pumps are expensive and sizing them to 100% of the peak is not an efficient use of capital £/carbon emissions saved. Gas peaking plant is utilised to top-up generation capacity at peak times when the heat pumps and thermal storage are 100% utilised (and during maintenance). Demand reduction as covered in section 15.1 can reduce the peak and therefore the utilisation of gas peaking plant in turn reducing carbon emissions. Degasification of peaking plant also serves to reduce carbon emissions by changing the peaking technology and/or input fuel. For example, using electrically driven air source heat pump or direct electric peaking.

S.2.3 Reduce Embodied Carbon

The construction of large infrastructure such as district heating projects carries a large, embodied carbon penalty. To minimise this impact, the network contractor and operator can:

- Refurbish rather than demolish and rebuild
- Prioritise the use of low whole lifecycle embodied carbon materials
- Use low (preferably 0) Global Warming Potential (GWP) refrigerants

S.2.4 Carbon Offsetting

Following other the above measures there will still be residual carbon emissions that need to be offset. Carbon offsetting can be used to reach Net Zero emissions once other opportunities for reducing direct and indirect CO_2 emissions have been achieved. Any carbon offsetting strategy should adhere to the follow guidance from the Carbon Trust and the International Carbon Reduction and Offset Alliance (IOCA).[100] Carbon offsetting projects should be:

- *Additional* – To qualify as an offset, the reductions achieved by a project need to be additional to what would have happened in the absence of the project.
- *Permanent* – The offset should have a lasting, permanent effect.
- *Real* – The offset must be possible to implement and the impact of the offset quantifiable.

[100] International Carbon Reduction & Offset Alliance, *'Code of Best Practices for the Carbon Market'* (2008). Available at: https://www.icroa.org/The-ICROA-Code-of-Best-Practice

- *Verifiable* – In order to provide assurance on the quality and credibility of the offsetting project, ideally the project should be verified through a viable standard or offsetting scheme.
- *Traceable* – The offset must be transparent and provide proof of the offset through monitoring and regular reporting, ensuring traceable progress and commitment to offsetting best practices.
- *Designed to minimise leakage* – The project must be designed to ensure that there are no increases in emissions beyond the project boundary attributable to the project activity, a phenomenon known as 'leakage'.

Although the primary focus is on reducing emissions, where possible, projects should maximise co-benefits that address broader sustainable development goals, such as the UN 'Global Goals' shown below.

Figure 15-19. UN Global Sustainable Development Goals

S.2.4.1 Approaches to Carbon Offsetting

In broad terms, approaches to carbon offsetting generally involve either carbon *sequestration* (e.g. through afforestation) or carbon *avoidance* (e.g. by investing in renewable energy technologies that reduce reliance on fossil fuels). Examples include:

Restoring woodlands or creating new ones, for instance by converting low-grade agricultural land. These also provide a wide range of co- benefits to wildlife, air quality, and human health.

Streetscapes, parks and other landscaping features could accommodate tree planting or other forms of diversification such as wildflower meadows. New buildings could include green walls and roofs.

Investment in solar photovoltaic (PV) farms offer a relatively cost-effective means of carbon offsetting, although large installations would need to be delivered off-site.

PV can also be incorporated into the built environment, on rooftops, car parks and other public realm features such as bus shelters. Alternatively, solar water heating (SWH) systems can be installed where there is sufficient hot water demand.

Investment in wind energy projects. Onshore wind turbines are currently the most cost-effective means of renewable electricity generation and can be co-located with other land uses such as grazing and agriculture.

Provision of electric vehicle (EV) charging facilities, to promote the uptake of sustainable transport modes.

Contribution towards an established carbon offsetting scheme or purchase of 'carbon credits' such as the Woodland Carbon Code.

S.3 Reaching Net Zero: Next Steps

As stated above, the most important step towards reaching Net Zero will be to identify and implement all practicable options for reducing energy demands. Then, further analysis will be necessary to define the best combination of carbon offsetting techniques, identify real-world opportunities and develop a business case for those that offer the greatest potential, informed by detailed energy audits of buildings within Hounslow.

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