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Lewisham Town Centre Detailed Project Development

Prepared for Lewisham Council

Control Information

Revision	Description	Issued date	Checked
V05	Updated following further stakeholder engagement	28/04/2025	CW
V04	Sensitivity on 'Shopping Centre not connected' added, grant funding levels added to show commercialisation funding only, expanded on Heat Network Zoning	25/09/2024	AC
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This technical report is based on information available at the time of preparation. The findings and recommendations presented herein are provided in good faith and are based on reasonable assumptions. However, we do not guarantee the actual realisation of these assumptions or projections. Where we have relied on information, data, or inputs provided by third parties, we have assumed that such information is accurate and complete. We do not accept responsibility for any errors, omissions, or inaccuracies in this data, nor for the consequences of any such errors or omissions on the outcomes of this report.

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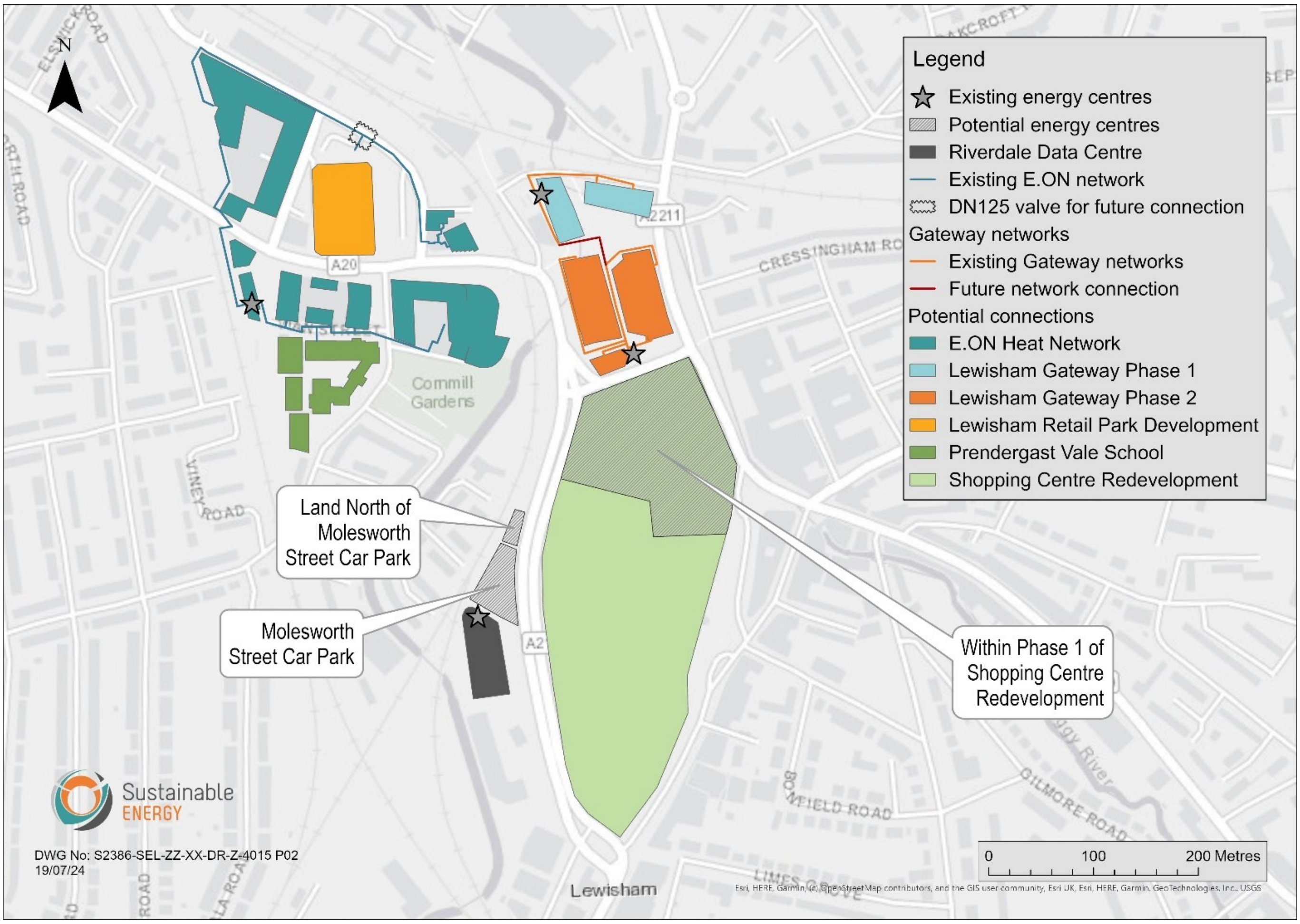
EXECUTIVE SUMMARY

This executive summary presents the findings of Work Packages 1 and 2 of the Lewisham Town Centre Detailed Project Development (DPD) Study, 2024. The project is funded and supported by the London Borough of Lewisham (LBL) and the Greater London Authority (GLA) Local Energy Accelerator (LEA) programme. The purpose of the study is to identify and evaluate opportunities to develop energy networks in Lewisham Town Centre. The work has been conducted by Sustainable Energy Ltd (SEL) and Amberside Advisors Ltd (AAL).

Heat Network Opportunity

A map summarising the main stakeholders, existing heat networks, energy centres, and key areas of land identified as potential energy centre locations within Lewisham Town Centre is shown below.



The table below summarises the heat network opportunity in Lewisham Town Centre.

Opportunity	Metric
Residential connections	3,379 residential dwellings from two new developments
Commercial connections	3 existing heat networks and 25,201 m^2 of new commercial developments
Diversified peak demand	8.0 MW
Annual demand	26,592 MWh

There is a significant opportunity for a heat network in Lewisham Town Centre which would exploit the heat demands of planned new developments, potential for heat supply to existing heat networks in the area and recovery of waste heat from the Riverdale Data Centre. However, engagement with the key project stakeholders identified that the main project risk is whether the timing of the network build out could align with key stakeholder milestones and construction timeframes. For example, if the heat network is not developed in time to supply heat to planned new developments (Landsec Shopping Centre Redevelopment and the Retail Park Development in 2028) then they will likely be built with individual low carbon heat solutions instead (such as ASHP), and so may only connect to the network when the ASHPs reach end of useful life (after circa 15 years). Existing buildings may also need to progress the retrofit of individual low carbon heat solutions to meet their net zero targets if a network solution is not available within the timescale required.

Also, it should be noted that the three existing heat networks in the area (Loampit Vale, Gateway 1 and 2) are currently supplied with heat via gas fired CHP plant. These networks are planned to decarbonise by 2030-2032 to align with the operators' decarbonisation targets and end of useful life of CHP plant and so this is a critical timeline for further network development.

Preferred Solution (Option A)

A range of heat technology options were assessed, but a heat network utilising waste heat offtake from Riverdale Data Centre will offer the highest heat source temperatures. This will result in the highest heat pump efficiency and potentially the lowest heat sale tariffs and lowest carbon intensity, offering the best performance against the key CSFs. Waste heat offtake from Riverdale Data Centre also has the potential to supply a wider town centre area; circa 5 MW of low-grade heat could be diverted from the data centre cooling towers, and in the future, the rooftop air chillers could provide additional heat offtake capacity. This solution also includes external air heat exchangers to allow the heat pumps to operate as air source heat pumps as a redundancy measure if heat from the data centre is offline for any reason. Therefore, heat pumps with the heat source of waste heat offtake from Riverdale Data Centre is taken forward as the preferred option.

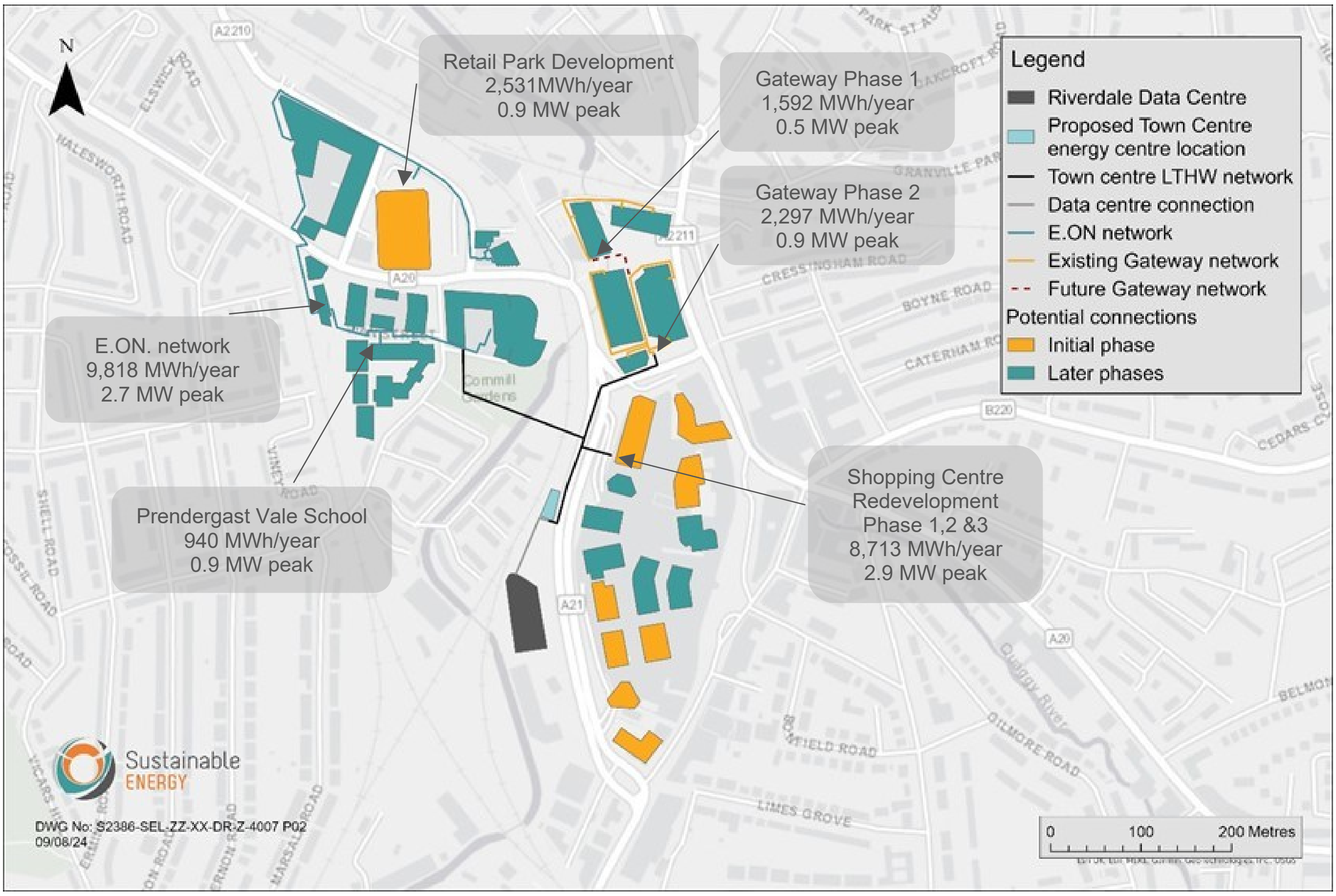
The fully built out network includes:

- The Landsec Shopping Centre Redevelopment,
- Provision of low carbon heat to the main E.ON network, including Prendergast Vale School connection
- The Retail Park Development which would be supplied via the existing E.ON. heat network through a sleeving arrangement
- Gateway 1 & 2 (offsetting heat supplied by the existing CHP plants)

The economics for the preferred network solution are shown below.

Solution A - Summary of key metrics and technology	
	Fully built out network
Total heat demand (excl. losses), kWh	26,591,738
Network trench length, m	551
Network linear heat density, MWh/m	48.2
Network peak demand (incl. losses), kW	8,044
Energy centre size, m^2	348
Thermal stores, litres	120,000
WSHP capacity, kW	4,000
Air heat exchangers (for redundancy), kW	2,000
Electric peak and reserve boiler capacity, kW	7,000
% heat demand met by low carbon / renewable technology	92%
Estimated phase start year	2030

The heat connections for the preferred solution for the Lewisham Town Centre Heat Network are shown below.



Economic and Carbon Summary

The economic and carbon summary for the full Lewisham Town Centre Heat Network is shown below:

Summary of preferred solution (A) economics, CO_2e emissions and intensity				
		Without grant funding	With commercialisation funding only	With 35% grant funding
Total capital costs (including contingency)		£15,668,166		
Total connection charge		£8,227,500		
Total grant funding			£673,150	£5,358,056
25 years	IRR	8.1%	9.1%	24.8%
	NPV (3.5% discount rate)	£4,871,370	£5,544,520	£10,229,426
	Simple payback	11 years	10 years	5 years
	Net income	£11,953,720	£12,626,870	£17,311,776
	Network CO_2e emissions	7,587 tCO_2e		
40 years	IRR	8.7%	9.6%	23.9%
	NPV (3.5% discount rate)	£8,170,397	£8,843,547	£13,528,454
	Simple payback	12 years	11 years	5 years
	Net income	£23,041,347	£23,714,497	£28,399,404
	Network CO_2e emissions	8,878 tCO_2e		
First year CO_2e intensity of heat delivered		53 g/kWh		

Key assumptions:

- Variable heat tariff 9.01 p/kWh
- Fixed heat sale tariffs £14.64/kW of connection capacity/day
- Year 1 (2028) energy centre electricity tariffs of 12.7 p/kWh
- Connection charges based on avoided costs of ASHP installation at £750/kW
- CAPEX includes contingency

Energy Centre Constraints

The key constraint to developing a heat network aligned with stakeholder timeframes and milestones is the securing of a suitable location for the energy centre. The shortlisted options identified are:

- **Molesworth Street Car Park**: This location is adjacent to the preferred heat source (data centre waste heat offtake) and has buildable land circa 1,500 m². However, if the planned Bakerloo Line Extension (BLE) goes ahead, TfL will be required to relocate its 18 bus bays (currently located at Thruston Road), during the BLE construction period of circa 8 years. TfL has identified the Molesworth Street Car Park as the preferred location for relocating the bus stands during the construction of the BLE. The site has a restriction within the title register stating that no disposition is to be registered without the consent of The London Development Agency, TfL and the London Bus Services Limited. Further discussions/negotiations are needed with TfL to confirm if the BLE extension and bus stands relocation is going ahead and if so to understand whether a compromise can be reached over the use of the land (which may include a possible joint use of the space, or use of part of the space to accommodate a network energy centre).
- **Land North of Molesworth Street Car Park**: This location is adjacent to the preferred heat source (data centre waste heat offtake) and has buildable land of circa 400 m². This land is Council-owned but would require the removal of several trees and further engagement with LBL for planning & biodiversity implications. Discussions/negotiations with TfL would still be required for the installation of network pipework across the adjacent car park to connect the data centre to the energy centre.
- **Shopping Centre Redevelopment**: It is proposed that an energy centre could be implemented as part of the new Shopping Centre Redevelopment, or located within a new dedicated energy centre building on site which would require negotiations with the developer. This location is not preferred by the Shopping Centre developer and is further away from the preferred heat source which may cause technical complexity.

The preferred location is the Molesworth Street Car Park as it has closest proximity to the data centre heat offtake and a large buildable area. However, if the BLE goes ahead then this may mean that the car park and the adjacent land to the north of the car park are impacted and may not be available, or if a compromise can be reached on the land use, it is not likely to happen in time for an energy centre to be built to meet the heat on date of the Landsec Shopping Centre Redevelopment and Retail Park Development (2028). Therefore, interim/enabling solution have been identified.

Interim Enabling Solution (Option B)

If there are delays to developing an energy centre at Molesworth Street Car Park or on land adjacent to the car park, an interim solution could be to install heat pump plant above the existing data centre CCHP energy centre. An additional floor could be added, or the space within the existing CCHP energy centre could be repurposed following the removal of the existing CCHP plant (current building footprint is circa 250 m²). The smaller footprint would result in a reduced heat pump capacity being installed to utilise waste heat from the data centre, but it would be sufficient to supply the Landsec Shopping Centre Redevelopment, and the Retail Park Development which require heat by 2028. It is proposed that the full energy centre would then be built out at Molesworth Street Car Park and/or land to the north of the car park when it come available. This solution was identified as potentially attractive/investable by SDCL, the data centre energy centre owner.

The Council should continue engagement with TfL with regards to the use of the Molesworth Street Car Park and adjacent land and if it becomes clear that there will be delays/barriers to the use of the land which will prevent the Initial Phase connections being supplied by 2028, then the enabling solution should be progressed.

Delivery Strategy and Funding Options

There are two key factors that are motivating the Council with regards to their selection of delivery approach:

Council Capacity – There is limited capacity in the Council to sponsor a heat network scheme i.e. the Council does not have enough resource (both in terms of finance and person-hours) available to deliver a heat network.

Privately Owned Heat Loads – There are a very limited number of nearby Council-owned / public sector buildings to connect to the heat network. The main heat loads are either privately owned communal / small-scale heat networks or large private developments.

The Council also confirmed that their priority is for construction and operation of the heat network to occur as soon as possible, and hence would prefer to cede control of the scheme to a third-party sponsor / developer to ensure the scheme is delivered.

Through discussions with the Council to date, it was found that a private sector led delivery / 'Energy as a Service' model is most suitable for the Lewisham Town Centre Heat Network. This is primarily because there is limited capacity in the Council to sponsor the scheme and most heat loads are privately owned.

Until thorough soft market testing has been undertaken and a business case developed, Lewisham Council's role should remain under discussion. The presence of existing 'island' networks (e.g. E.ON's Loampit Vale scheme) whilst presenting an opportunity, may also present some 'incumbency' challenges. For example, if Lewisham Council selected a third-party ESCo that is not E.ON, then an agreement between the third-party ESCo and E.ON might be required to make the wider scheme viable, which could potentially be commercially challenging. There may also be potential impacts of the forthcoming Heat Network Zoning regulations and an incoming Zone Coordinator for Lewisham with the power to determine the zone delivery model, facilitate the procurement process and enforce local zoning requirements is anticipated.

If the project progresses to the next DPD stage, a detailed preferred funding strategy should be developed.

Next Steps

The Council's ultimate goal is to decarbonise the town centre, with affordable tariffs, and the development of a district heating network is the optimal solution to achieve this.

To formulate a meaningful strategy for the Council to take forward, we have assumed the following key points based on discussions with the Council:

- The Council is not going to provide any capital investment to the project
- The Council does not want to create a formal JV
- The Council would not be a major customer to the heat network, as there are no Council-owned buildings being proposed to connect
- The Council's major role is to enable the development of the network

Therefore, it is recommended that the Council facilitates a market selection exercise for the energy centre land (Molesworth Street Car Park and/or land to the north of the car park) which will then ultimately facilitate an investor to develop the network. The Council will need to embark on work around land identification which will include technical, legal and title due diligence to make the opportunity appealing to the market. Dependent on the Council's priorities, reaching this point can be achieved in either a more or less developed way:

- Minimum Developed Entry – Given that the Council's role is likely to be light touch, the energy centre land could be marketed on the basis of the work done to date, leaving it to the bidders to ultimately "solve" the issues highlighted in this report
- Maximum Developed Entry – The Council could undertake more-in house development of the project, including a reference design and a financial model to be utilised for soft market testing with the private sector and as an appraisal tool for the selection process.

With regards to funding, it is recommended that the Council applies for commercialisation funding under the next round of GHNF to pay for the necessary advisor costs to facilitate the market selection exercise. Zero Carbon Accelerator and Heat Network Delivery Unit can also provide funding for advisor costs and should be explored as an immediate action. A construction grant application should also be considered (GHNF or otherwise) to increase the attractiveness of the project to the market.

CONTENT

GLOSSARY

Acronym	Meaning	Description
AAL	Amberside Advisors Ltd	Commercial and Financial Consultants
ASHP	Air source heat pump	An air source heat pump system is an energy-efficient solution that extracts heat from the outdoor air and transfers it inside to provide heating and hot water.
	Base Case	The core network identified and modelled in the Outline Business Case. This has progressed over the Project life to be a WSHP and electric peak and reserve boilers
	Boreholes	The permanent abstraction and discharge boreholes that will access the chalk aquifer water.
BAU	Business As Usual	What would have happened without the change or intervention being considered
BHIVE	DESNZ Heat Investment Vehicle	An initiative run by DESNZ, to allow public sector heat network owners/developers in England and Wales to procure funding and funding-related services for their heat network projects from a range of potential funders.
BLE	Bakerloo Line Extension	A proposed expansion of the London Underground’s Bakerloo line. The extension plans to extend the line from its current southern terminus at Elephant & Castle to Lewisham, with potential further extensions to Hayes and Beckenham Junction.
CAPEX	Capital expenditure	Capital expenditure or capital expense is the money an organisation or corporate entity spends to buy, maintain, or improve its fixed assets. In this case a capital expense of developing heat network.
CCHP	Combined cooling, heat & power	The generation of electricity, heat and cooling simultaneously
CO_2e	Carbon dioxide equivalent	A quantity that measures the global warming potential (GWP) of any mixture of greenhouse gases using the equivalent amount or concentration of carbon dioxide
	Clusters	Buildings / sites grouped based on heat demand, location, barriers, ownership and risk
CA	Coal Authority	The Coal Authority is a non-departmental public body of the United Kingdom government sponsored by the Department for Energy Security and Net Zero
CoP	Coefficient of Performance	Coefficient of performance for a heat pump is how many units of heat are produced per unit of input electricity
CHP	Combined heat and power	The generation of electricity and heat simultaneously in a single process to improve primary energy efficiency compared to the separate generation of electricity (from power stations) and heat (from boilers)
CSF	Critical Success Factor	Necessary factors for an organisation or project to achieve its goals and objectives.
	Commercialisation	Predevelopment stage of the Project immediately prior to Financial / Contract Close when all contracts and agreement will be procured, and Project will be subject to final approvals
	Counterfactual	The reference case of should the heat network not happen, for which heat users would require individual air source heat pumps

Acronym	Meaning	Description
	D&B Contractor	Design & build contractor who will deliver the detailed design and installation of the Heat Network
D&B	Design & Build	
DEC	Display Energy Certificate	Display Energy Certificates are designed to show the actual energy performance of public buildings.
DEFRA	Department for Environment, Food and Rural Affairs	A government department in the United Kingdom responsible for overseeing environmental protection such as air and water quality, food production and safety, and rural affairs.
DESNZ	Department for Energy Security and Net Zero	The Department for Energy Security and Net Zero is a ministerial department of the Government of the United Kingdom. It was established on 7 February 2023 by a cabinet reshuffle under the Rishi Sunak premiership. Previously known as BEIS.
DPD	Detailed Project Design	Detailed Project Development stage of creating a project, as defined by HNDU, which follows Feasibility stage and comes prior to Commercialisation
DH	District Heating	The provision of heat to a group of buildings, district or whole city usually in the form of piped hot water from one or more centralised heat source
DHN	District Heating Network	The heat network that is proposed to be developed as a result of this OBC to comprise the Energy Centre, Distribution Network and Substations
	Economic Case	document which forms part of this OBC
EC	Energy centre	The building or room housing the heat and / or power generation technologies, network distribution pumps and all ancillary items, whose proposed location is given in the Design Report
EDGE	The London Efficient and Decentralised Generation of Energy Fund	A £100 million initiative established to promote and support decarbonisation projects across London. Jointly funded by the Mayor of London and Sustainable Development Capital LLP (SDCL). This fund aims to drive significant reductions in energy usage, greenhouse gas emissions, and other pollutants.
EER	Energy Efficiency Ratio	A measure used to evaluate the efficiency of cooling devices, such as air conditioners and heat pumps. It is defined as the ratio of the cooling output to the electrical energy input.
	Energy demand	The heat / electricity / cooling demand of a building or site, usually shown as an annual figure in megawatt hours (MWh) or kilowatt hours (kWh)
EfW	Energy from Waste	A process of generating energy, typically electricity or heat, from waste materials. This process involves converting non-recyclable waste into usable energy through various technologies.
ESCo	Energy Service Company	
	Feasibility	Stage of creating a project, as defined by HNDU, which comes prior to DPD stage
GA	General Arrangement	A type of technical drawing used in engineering, construction, and architecture to provide an overall view

Acronym	Meaning	Description
		of a project or component. It is typically used to convey the layout, arrangement, and relationships between various elements of a design.
GEA	Gross External Area	A measurement used in building design and real estate to determine the total area of a building, including all external walls.
GIA	Gross Internal Area	A measurement used in building design and real estate to determine the total usable space within a building. It is calculated from the internal faces of the external walls and includes all areas within the building's envelope.
GIS	Geographic Information System	
GLA	Greater London Authority	Strategic government body responsible for overseeing and coordinating various aspects of governance and administration in Greater London. The GLA comprises two main components: Mayor of London and London Assembly.
GHNF	Green Heat Network Fund	The £288m capital grant funding programme for heat networks announced by Government that opened in April 2022
GSHP	Ground Source Heat Pump	A ground source heat pump system is an energy-efficient solution that extracts heat from the ground and transfers it inside to provide heating and hot water.
HoT	Heads of Terms	A non-binding document (sometimes referred to as a Letter of Intent) that outlines the main terms and conditions agreed upon by the parties involved in a negotiation. It includes the fundamental elements of the proposed agreement.
PHE	Plate Heat Exchanger	A device in which heat is transferred from one fluid stream to another without mixing - there must be a temperature difference between the streams for heat exchange to occur
HH	Half Hourly	Half hourly energy data
HIU	Heat Interface Unit	Defined point of technical and contractual separation between the Distribution Network and a heat user
HN	Heat Network	The heat network that is proposed to be developed as a result of this OBC to comprise the Energy Centre, Distribution Network and Substations
HNDU	Heat Network Delivery Unit	The Heat Network Delivery Unit within DESNZ
HNCoP	Heat Networks Code of Practice	Document that outlines best practices, standards, and requirements for the design, installation, operation, and maintenance of heat networks.
	Hurdle rate	The minimum internal rate or return that is required for a network to be deemed financially viable
IAG	Interdepartmental Analysts Group	
IRR	Internal Rate of Return	Defined as the interest rate at which the net present value of all the cash flows (both positive and negative) from a project or investment equal zero, and used to evaluate the attractiveness of a project or investment
JV	Joint Venture	

Acronym	Meaning	Description
kVa	Kilovolt amperes	Unit of measurement used to describe the apparent power in an electrical system
kWe	Kilowatt electrical	Unit of measurement used to denote the electrical power output of a generator, power plant, or electrical equipment. It represents the amount of electrical power that is generated or consumed
kWh	Kilowatt hour	A non-SI unit of energy which means the energy delivered by one kilowatt of power for one hour
kWth	Kilowatt thermal	A unit of power used to measure thermal energy output or heat generation. It specifically refers to the rate at which heat energy is produced or consumed.
LBL	London Borough of Lewisham	
LEA	Local Energy Accelerator	A £6m programme providing expertise and support to organisations to develop clean and locally generated energy projects.
LGA	Local Government Association	
LHD	Linear Heat Density	Total heat demand divided by indicative pipe trench length - it provides a high-level indicator for the potential viability of network options and phases
MVA	Megavolt Ampere	
MWh	Megawatt hour	Equals 1,000 kilowatts of energy per hour
MWh/m	Megawatt hour per meter	
Mbus	Meter bus	
MEEF	The Mayor of London's Energy Efficiency Fund	
MRMU	Metered ring main unit	
NPV	Net Present Value	Net present value, the value of investment discounted back to the present day using a determined discount rate (typically 3.5% as per Green Book guidance)
NOx	Nitrogen Oxides	
O&M	Operation and Maintenance	
OPEX	Operational Expenditure	
OBC	Outline Business Case	Document which comprises the Strategic, Economic, Commercial, Financial and Management Cases
	Peak and reserve plant	Boilers which produce heat to supply the network at times when heat demand is greater than can be supplied by the renewable or low carbon technology or when the renewable or low carbon technology is undergoing maintenance (also called auxiliary boilers)
	Phases	Construction phases in which it is proposed the Heat Network will be delivered
PFD	Process Flow Diagram	A type of flowchart that illustrates the relationships between major components at an industrial plant
PFI	Private Finance Initiative	

Acronym	Meaning	Description
PSDS	The Public Sector Decarbonisation Scheme	Provides grants for public sector bodies to fund heat decarbonisation and energy efficiency measures.
PCRs	Public Contracts Regulations	Public Contracts Regulations 2015
PPP	Public Private Partnerships	
PWLB	Public Works and Loans Board	
REMA	Review of the Electricity Market Arrangements	
RFI	Request For Information	Formal process used to gather information from potential connections and heat sources.
SEL	Sustainable Energy Ltd	Technical consultant
SPF	Seasonal Performance Factor	The average Coefficient of Performance (CoP) of a heat pump over the full heating season.
SDCL	Sustainable Development Capital Ltd	
SEEIT	Sustainable Energy Efficiency Income Trust PLC	
Social IRR	Social Internal Rate of Return	Internal rate of return of a project, including the additional social benefits of CO_2e savings and improvements in air quality
Social NPV	Social Net Present Value	Social net present value
SPV	Special Purpose Vehicle	Non-recourse contractual entity through which funding, development and operation of the Heat Network is likely to be managed
	Substation	A defined point on the property boundary of the heat user, comprising a heat exchanger, up to which the heat network is responsible for the heat supply
	Supplier of Last Resort	Party with responsibility to honour the heat delivery contracts with heat users if the SPV fails
TEM	Techno-Economic Model	Tool used to evaluate the technical performance and economic viability of the project.
TfL	Transport for London	Local government body responsible for the planning, coordination, and management of transportation services in Greater London.
	Thermal Store	Storage of heat, typically in an insulated tank as hot water to provide a buffer against peak demand
UKIB	UK Infrastructure Bank	
UKMBA	UK Municipal Bonds Agency	
WSHP	Water Source Heat Pump	A water source heat pump system is an energy-efficient solution that extracts heat from a water source and transfers it inside to provide heating and hot water.

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1 INTRODUCTION

This report presents the findings of the Lewisham Town Centre Detailed Project Development (DPD) Study, 2024. The project is funded and supported by the London Borough of Lewisham (LBL) and the Greater London Authority Local Energy Accelerator (LEA) programme. The purpose of the study is to identify and evaluate opportunities to develop energy networks in Lewisham Town Centre. The work has been conducted by Sustainable Energy Ltd (SEL) and Amberside Advisors Ltd (AAL).

1.1 Project Scope

SEL and AAL were commissioned to undertake a DPD study for the Lewisham Town Centre area. The scope is divided into the following key work packages:

- Work Package 1: Technical
- Work Package 2: Commercial
- Work Package 3: Financial
- Work Package 4: Preparation of Outline Business Case
- Work Package 5: Support with a Green Heat Network Fund (GHNF) bid

Work Packages 1 and 2 commenced in parallel in March 2024 with a target completion date of the end of June 2024 to meet GLA requirements. This report presents the initial findings of Work Package 1 (WP1); a summary of the key scope elements for WP1 and Work Package 2 (WP2) is shown below:

WP1: Technical Workstream:

- Review of previous work
- Energy demand assessment
- Develop and formalize Critical Success Factors (CSFs)
- Heat supply assessment
- Technology sizing and strategy for central plant room and backup plant options
- Design of central plant and distribution system (RIBA Stage 2)
- Techno-economic modelling
- Optimism bias assessment
- Risk assessment

WP2: Commercial Workstream:

- Heat pricing strategy
- Develop commercial strategy identifying roles, responsibilities, and governance
- Identify preferred delivery structures
- Develop procurement strategy
- Consider legal, commercial, and contractual arrangements impacting sources of finance
- Draft, negotiate, and sign Heads of Terms (HoTs) with key stakeholders

A breakpoint is planned at the end of WP2. On completion of WP2, the financial viability of the project will be understood, and based on findings and stakeholder interest, LBL will determine whether to progress the DPD to Work Package 3 (WP3) and beyond.

1.2 Project Background

In April 2019, LBL declared a climate emergency and set an ambitious goal of becoming carbon neutral by 2030. To achieve this, LBL published the Lewisham Climate Emergency Strategic Action Plan in March 2020, outlining the steps needed to ensure a greener and more sustainable future. A key part of this plan is the implementation of district heat networks (DHN) to support the goal of reducing greenhouse gas emissions in the borough to net zero.

Lewisham Council aims to reclassify the town centre as a Metropolitan centre in the London Plan, and to that end is proactively managing developments within the town centre area. There are significant opportunities for growth and regeneration in the town centre, and the Council will play a crucial role in the revitalisation and renewal of the area. The Lewisham Local Plan outlines an ambitious program to facilitate investment into neighbourhoods and sustainably manage long-term growth; the Local Plan also aligns with the implementation of the London Plan and its Good Growth policies.

Previous Work

In late 2020, LBL commissioned the Energy Masterplan study and updating of the Lewisham Heat Map study conducted in 2010. This study re-examined the demands across the borough and identified Lewisham Town as one of eight high heat density clusters with high potential for an efficient heat network development.

Building on the previous studies, in 2022, Buro Happold conducted a detailed techno-economic feasibility study for Lewisham Town Centre. The study proposed two solutions: an ambient network supplying the Lewisham Shopping Centre Redevelopment and a low temperature hot water heat network for the remaining town centre connections.

The study proposed a short-term solution utilising 2 MW of waste heat offtake from the Riverdale Data Centre Combined Heat and Power (CHP) and absorption chiller circuit. This short-term solution would supply an ambient network, with additional Air Source Heat Pumps installed at the energy centre within the Shopping Centre Redevelopment to supplement the waste heat and provide cooling to the data centre. An alternative energy centre site was also identified at Molesworth Street Car Park, however at the time of the previous study this site had been marked as a potential social housing development site by the LBL.

The long-term solution proposed was a low temperature hot water heat network (heat provided at 90°C – 70°C) to supply the remaining heat demand of the town centre, utilising 3 MW of waste heat from the Riverdale Data Centre. The long-term solution considered plans by Riverdale Data Centre to retire the CHP engines as the primary source of cooling, to meet net-zero targets. As a result, it was identified that the heat pump cooling capacity could be increased to 5 MW, to enable the sale of baseload cooling to the data centre.

The study identified a promising opportunity for a district heat network (DHN) within the town centre, which could deliver significant carbon savings compared to the counterfactual solutions; on this basis, the Council progressed the project to DPD stage and commissioned delivery of the Outline Business Case (OBC).

Heat Network Zoning

In December 2023, the Government published a consultation on Heat Network Zoning legislation, with the resulting regulation expected to become law in 2025. The proposed zoning legislation aims to drive the development of heat networks, where they provide lowest cost, low carbon heat to the consumer through regulation, mandating powers and market support. Current policy guidance would require both heat users and waste heat generators, such as the Riverside Data Centre, to connect to a heat network.

The Heat Zoning policy intention is:

- To give project sponsors and investors greater assurance of the predicted demand for heat networks by giving certainty over types of building that can be required to connect to a district heat network and to use the heat provided (where it is cost-effective to do so) within a Heat Network Zone (HNZ);
- To help to support the delivery of viable, large-scale heat networks and help overcome barriers to deployment faced by the heat network market;
- To drive accelerated development of heat networks in line with viable future energy pathways for urban heat decarbonisation, to achieve UK Net Zero commitments.

Plans for Lewisham Town Centre

Despite its inner London location, Lewisham currently lacks direct access to the London Underground network. The London Plan commits to extending the Bakerloo line from Elephant and Castle to Lewisham, with a possible southward extension in the future. Transport for London's proposals for the Bakerloo Line Extension (BLE) through Lewisham town centre could impact redevelopment and future land use due to new tunnels running underground and the potential location of a new 'station box' on the existing bus layover site (north of Thruston Road).

To accommodate the construction of the BLE and the station itself TfL is required to relocate their 18 bus bays currently located at Thruston Road, during the BLE construction period of circa 8 years.

The Molesworth Street Car Park, owned by LBL, which is located next to the potential heat network source, Riverside Data Centre, has a restriction within the title register stating that no disposition is to be registered without the consent of The London Development Agency, Transport for London (TfL) and the London Bus Services Limited. Currently, TfL has identified the Molesworth Street Car Park as the preferred and allegedly the only viable location for relocating the bus stands from Thruston Road during the construction of the BLE. This decision could potentially impact the data centre heat offtake solution.

1.3 Critical Success Factors

Critical Success Factors (CSFs) are used to clearly define the requirements that must be fulfilled before a project can be considered a success. CSFs enable the client, stakeholders and SEL to have an agreed-upon set of priorities to "test" all heat network heating solutions against, in case there is a need to define a hierarchy of potential solutions. A workshop to determine the projects CSFs was held on the 2nd of May 20204 via a Teams meeting.

The following Council representatives have taken part in development of the CSFs:

- Martin O'Brien, Head of Climate Resilience
- Patrick Dubeck, Director of Inclusive Regeneration
- Katharine Nidd, Director of Finance
- Tom Clarkson, Capital Accountant Core Accounting
- David Robinson, Major and Strategic Projects Manager Planning

The stakeholder group engaged in a group discussion to define the key objectives for the project. The key points have been captured as potential CSFs in Table 1; this includes a description of the CSF and proposed measurement methods. These will be used to appraise all heat supply technology options and to assess the overall techno-economic viability of the preferred heat network option.

Table 1: CSFs based on key points highlighted in the workshop

CSF	Description	Proposed measurement methodology	Who will measure?
Heat network should provide carbon savings and contribute to stakeholders' carbon reduction plans	The heat network should provide lower carbon heat to stakeholders compared to their existing heat supply and be compliant with future development requirements	Compare the carbon intensity of the proposed heat network against the customers' levels	Technical consultants in the Economic Case
Heat network should enable wider decarbonisation in the borough and ensure the project is in line with planning policy and heat network zoning	The design should be optimised for high efficiency and resilience for an initial phase while allowing for future expansion of heat sources and connections	Wider opportunity will be identified within the design report as part of the full Outline Business Case (OBC), the proposed solution will be optimised and futureproofed	Technical consultants in the Economic Case

CSF	Description	Proposed measurement methodology	Who will measure?
The proposed heat network scheme should meet criteria for finance/ funding/ grant	The heat network should be developed to ensure it is attractive to investors or/and eligible for relevant government funding, e.g. Green Heat Network Fund (GHNF)	Compare metrics of the heat network against eligibility criteria for funding	Technical and financial consultants in the Economic and Financial Cases
Heat tariffs should be fair and compliant with future regulation and potential funding requirements	The heat network should offer affordable heat tariffs for LBL residents	Solutions with higher efficiencies that offer a potential for lower heat tariffs will be prioritised	Technical and commercial consultants in the Economic and Commercial Cases
The proposed scheme should enable positive impact on the local environment	The proposed heat network scheme should have positive or neutral impact on the local environment e.g. air quality	Demonstrate reduction in local pollutants e.g. reduced NOx emissions	Technical consultants in the Economic Case

Other points mentioned in the workshop that are important for the project but may not be directly related to the CSFs include:

- Due to LBL's minimal asset ownership in the Lewisham town centre area, delivery models with low financial risks to the Council should be prioritised
- The role of the Council within the proposed delivery route should be clearly defined, and the risks/rewards associated with each commercial delivery structure identified
- If the energy centre is located on Council owned land, the value of the asset should be defined, and the energy centre design should be coordinated in a manner that allows the site to be used for other purposes in the future

1.4 Progress to Date

As set out in the CSFs, Lewisham Council's primary drivers are around ensuring the town centre has access to decarbonised heat, fair and compliant tariffs, and the scheme can attract finance (grant eligibility and private sources).

Lewisham Council's commercial role within the project was explored in detail in Commercial Workshop 1, which was supported by a briefing note that outlined a spectrum of commercial delivery models for the Council to consider, to steer the development work to follow.

During discussions with the Council, and Commercial Workshop 1, it was confirmed that the Council wishes to enable the project, which is complemented by the existence of several key private sector stakeholders nearby, including E.ON's Loampit Vale scheme, Lewisham Gateway Phases 1 and 2 communal-to-small scale heat networks, and the Riverdale Data Centre. Furthermore, as illustrated by the business case development to date, Lewisham Council has enabled highly productive discussions with critical potential heat loads, such as University Hospital Lewisham and large-scale landlords / developers.

However, Lewisham Council's role in the network delivery remains under discussion at this stage. This is largely due to the challenges that sometimes arise between the commercial interests for interconnecting adjacent networks, and incoming zoning regulations, anticipating an incoming Zone Coordinator role led at a local government level.

Figure 1 below summarises the progress of the business case development to date.

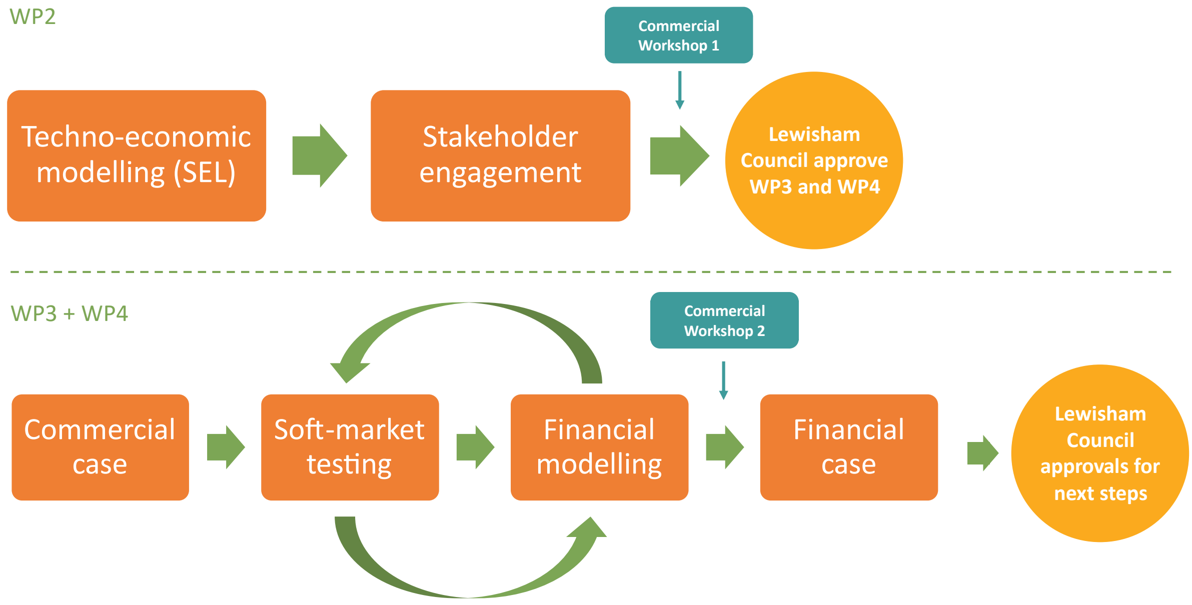


Figure 1: Business case development to date

2 DATA COLLECTION

A data collection exercise was undertaken to enable detailed energy mapping of existing and future energy demands, as well as potential heat supply options, data centre heat offtake opportunities, and barriers and constraints to the development of a district heat network in the area. Key stakeholders and potential key network customers were identified, and contact was established where possible.

2.1 Network Assessment Area

A map illustrating the key stakeholders within the Lewisham town centre area is shown in Figure 2.

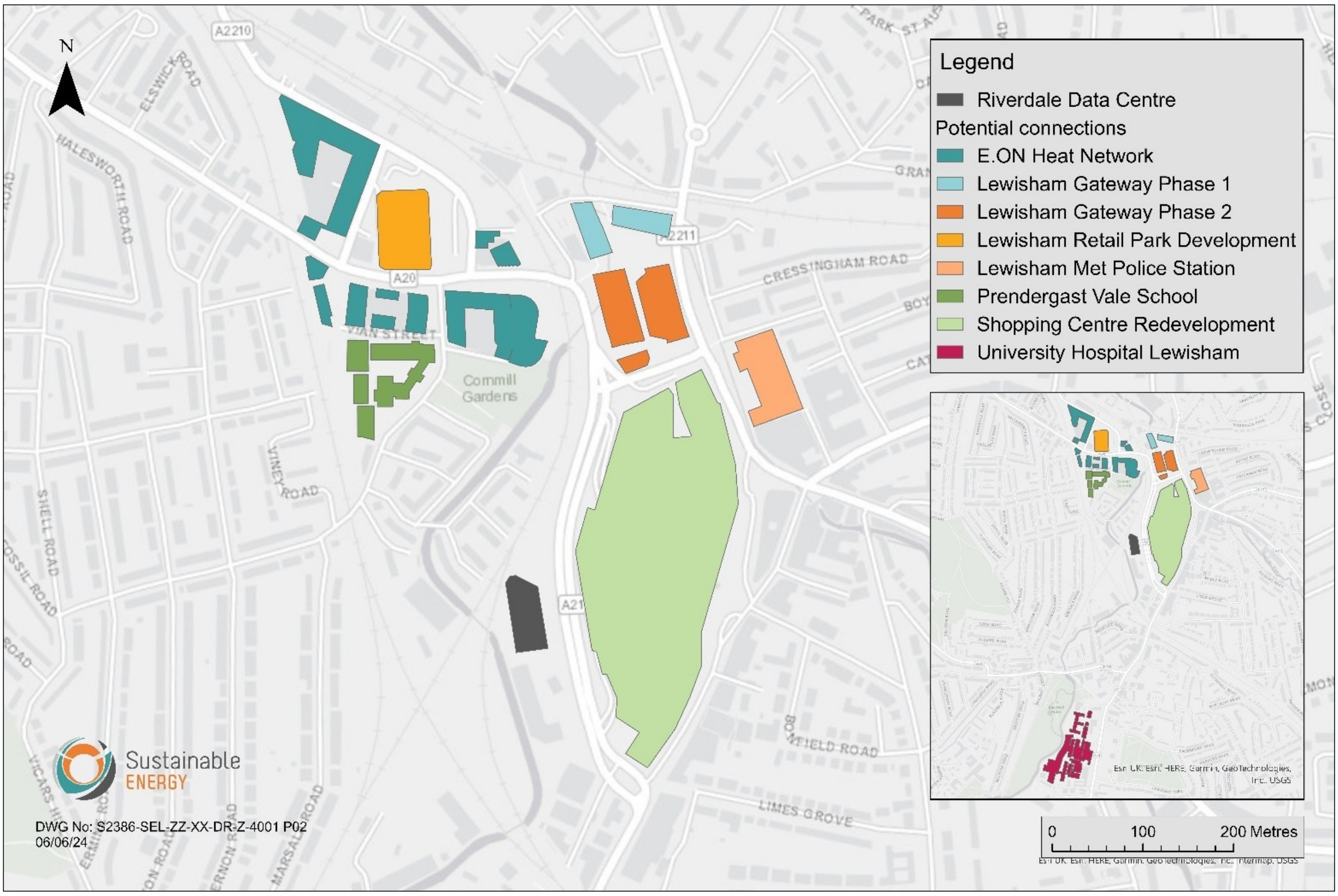


Figure 2: Map of the key stakeholders within Lewisham town centre

2.2 Stakeholder Engagement

LBL, SEL & AAL identified potential stakeholders and customers to request information such as energy data and tariffs, building use, occupancy levels and patterns, details of existing heating systems and plant room locations. Information requests were sent by email and, where possible, followed up through telephone calls. A summary of the technical and commercial information received from the data collection exercise is outlined in the section below; this has been used to assess the technical and commercial viability of the scheme. Table 2 provides a short description of each key stakeholder engaged and the date of the meeting.

Table 2: Description of stakeholders

Stakeholder	Description	Date of the meeting
E.ON	Operator of the nearby Loampit Vale heat network	16-Apr-24
Lewisham Gateway Phase 1 and Phase 2	Nearby residential development. Lewisham Gateway Phase 1 is owned by Fizzy Living LLP and Phase 2 by Get Living London	29-May-24 (Greystar) 17-Jun-24 (GLL)
Landsec	Owner and developer of the nearby shopping centre and residential development	24-Apr-24
The Metropolitan Police	Occupier of the PFI-financed police station	N/A
Lewisham and Greenwich NHS Foundation Trust	Owner of University Hospital Lewisham	13-May-24
Citibank	Owner of the Riverdale Data Centre	19-Apr-24

2.2.1 E.ON Heat Network

In 2014, E.ON adopted the Loampit Vale heat network under a 25-year ESCo agreement (with a 15-year extension option) granted by the network developer, Barratt London, as shown in Figure 3. It is understood that since then, Aviva has purchased the ESCo agreement from Barratt London, and now holds the underlying title of the existing heat network and much of the development, which likely includes control of the energy assets on site (TBC – subject to SEL and AAL due diligence).

Since 2014, the network has expanded to include connections to Thurston Road and the Exchange as shown in Figure 3. The existing E.ON heat network supplies heat to 1,967 residential customers and 4 commercial customers, including the Glass Mill Leisure Centre and the Exchange connection which has a bulk supply agreement in place; each of these supplementary contracts is backdated to the start of the initial ESCo agreement. E.ON has the planning obligation to run the energy centre, which would need consideration if additional heat loads were to be connected as there may be necessity to adapt the energy centre to include additional heat generation capacity.

The scheme also provides electricity via private wire to the leisure centre and Prendergast Vale School. E.ON has identified this heat network as a priority for decarbonisation and is one of approximately six schemes that they are currently decarbonising. Hence, E.ON has a significant interest in this study and the potential town centre scheme.

The existing Loampit Vale heat network is Combined Heat and Power (CHP) led, with remaining heat supplied by peak and reserve gas boilers and a biomass boiler; these supply a network peak demand of circa 2.3 MW. Figure 3 highlights all heat connections currently supplied by the E.ON Loampit Vale heat network.

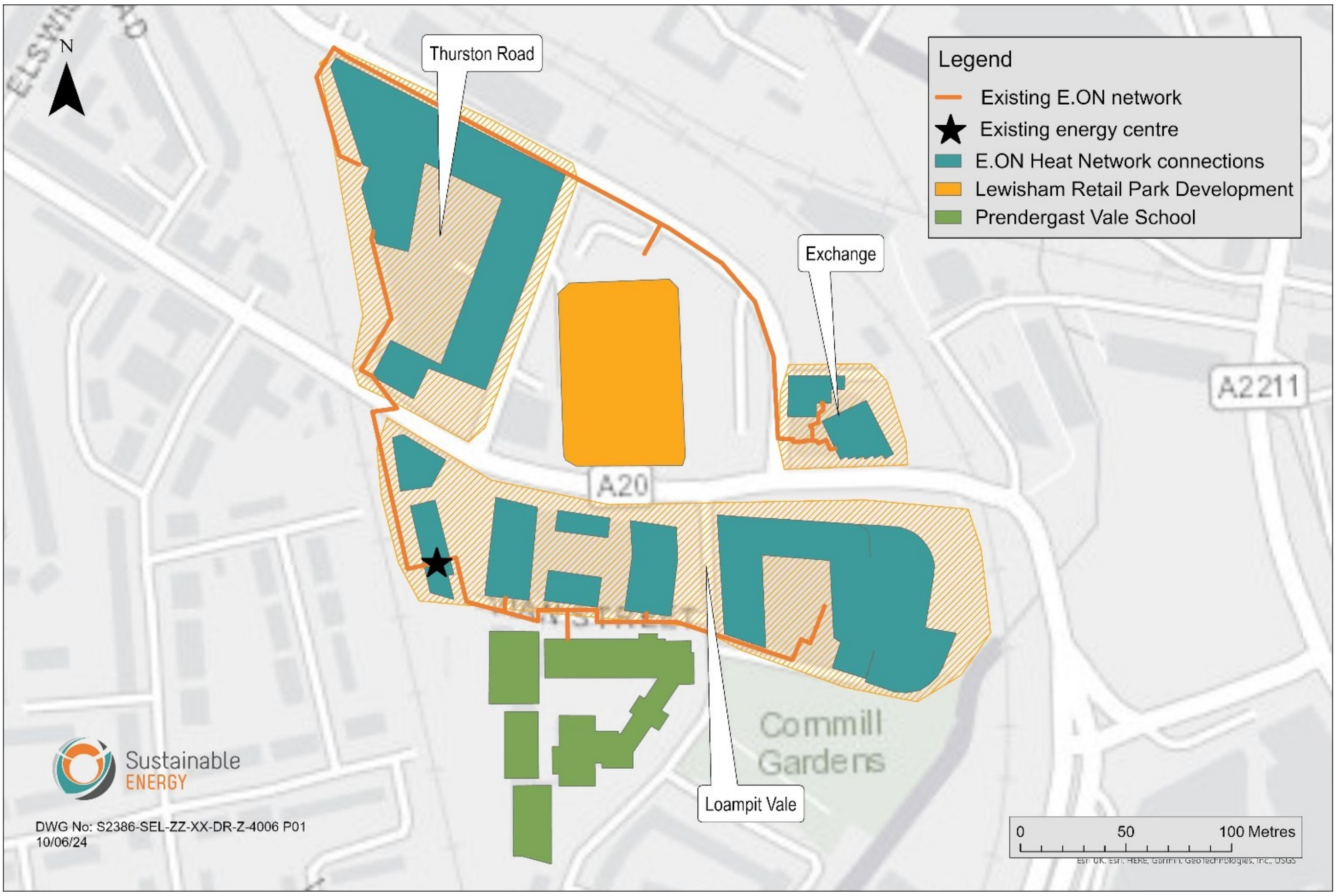


Figure 3: Existing E.ON heat network

A schedule of the energy centre plant currently supplying the Loampit Vale heat network is shown in Table 3. The biomass boiler is a Hoval STU 500 with a 15 m^3 wood pellet store which could provide circa 40-45 MWh of heat; however, the boiler has been out of operation for a significant period of time, and it is unknown whether it is in a suitable condition to be recommissioned. The Thurston Road plant room includes three secondary thermal stores specifically supplying the Thurston Road connections, in addition to the heat exchangers.

Table 3: E.ON Loampit Vale Network energy centre

Component	Metric
CHP plant	2 x 210 kWe/345 kWth
Gas boilers	6 x 950 kW
Biomass boiler	1 x 500 kW
Thermal stores	3 x 18,000 litres
Network flow temperature range (from HH data)	82°C – 59°C
Network return temperature range (from HH data)	59°C – 72°C

As shown Figure 3, when the network was extended to the Exchange connection in 2021, E.ON installed a DN125 branch for the potential future development at Lewisham Retail Park.

Prendergast Vale School

The Prendergast Vale School was first established as Lewisham Bridge Primary School. The school was renamed Prendergast Vale School in September 2011, when it was refurbished and redeveloped to accommodate both primary and secondary school pupils. The school is connected for both heat and private wire supply from the E.ON network, however the school currently only utilises the private wire supply, relying on its own boilers for heat supply. The energy demand of the school has been modelled based on DEC data and heat demand profiles for similar sites.

2.2.2 Lewisham Retail Park Development

In May 2024, Amro acquired the Lewisham Retail Park land for residential development. The company plans to deliver a landmark project, scheduled to launch with phased openings during 2028/29. The Lewisham Local Plan identified the retail park land as a potential development site with an indicative capacity of up to 529 homes. When SEL engaged with the LBL's planning department, it was indicated that the potential housing capacity of the site could actually be up to 700 homes.

2.2.3 Lewisham Gateway

The Lewisham Gateway development comprises Gateway Phase 1 and Gateway Phase 2, each owned and operated by different entities. Lewisham Gateway Phase 1 has been developed with much of the leasehold disposed, and the title retained by Fizzy Living LLP. AAL and SEL spoke with Fizzy Living LLP's property managers Greystar; they showed interest in any potential reductions in tariff and (to a lesser extent) carbon. The energy centre is operated by JFM Management, who were contacted by SEL but did not engage.

As shown in Figure 4, these two developments have their own energy centres and networks with plans to connect in the future. This study assumes that the connection of the two phases will occur before the Lewisham town centre network is developed.

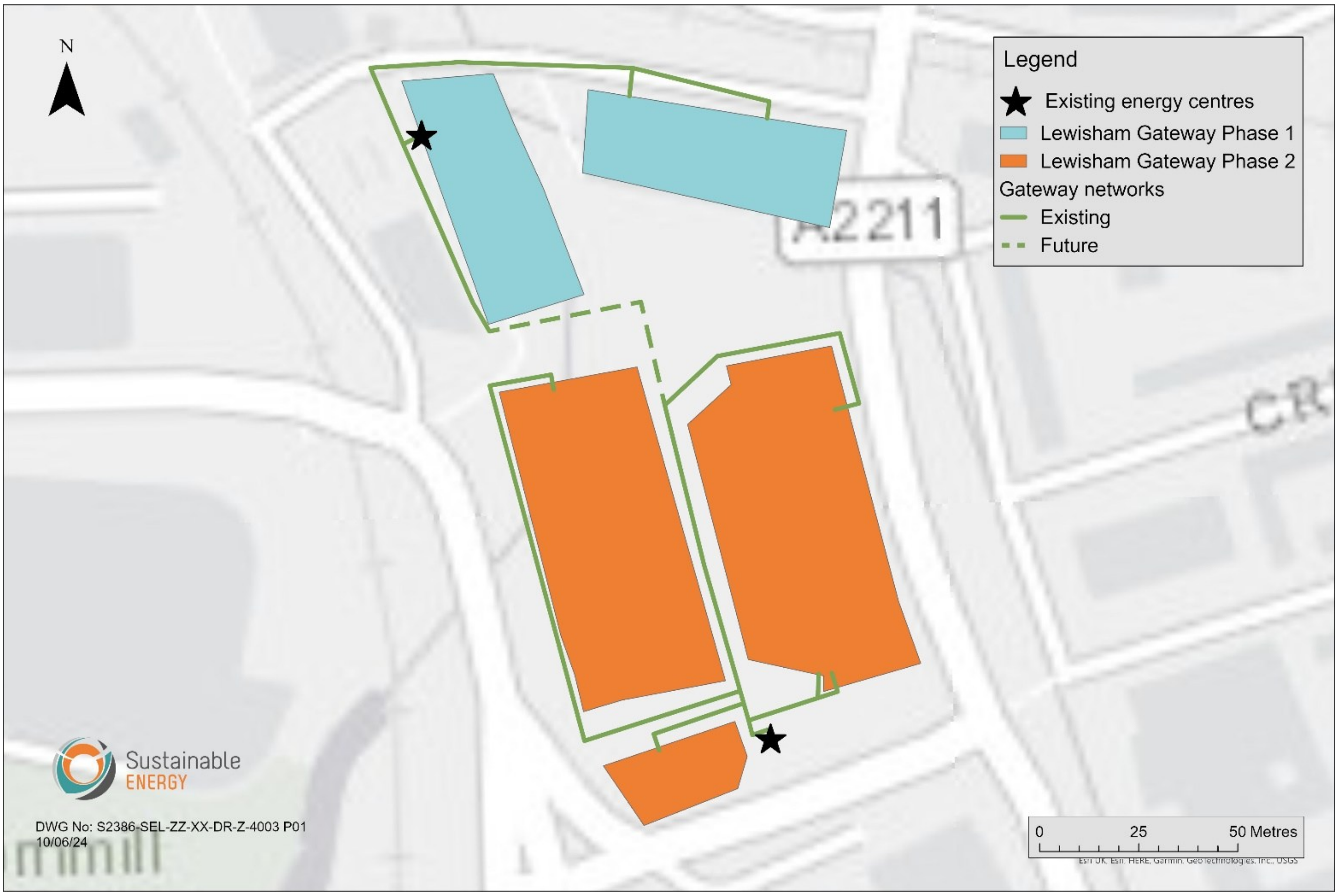


Figure 4: Gateway networks

Under development by Muse, Lewisham Gateway Phase 2 is owned and funded by Get Living London who are also the eventual long-term operators under a build-to-rent model. Get Living London will retain interest in the energy centre at the site (including gas CHP), and is set to enter into a long term ESCo agreement with another party who will take over the energy services for Gateway Phase 2 Notably, Get Living London and their major shareholders have ambitious net zero targets and, having met their Asset Director and Head of Net Zero, would be very interested to see an offer to connect to a green network (provided the network's green credentials passed their legitimacy tests).

Disclosure: AAL are currently engaged by Get Living London, to support them through procurement of an ESCo to provide energy services for Lewisham Gateway Phase 2.

It should be noted that Lewisham Gateway Phase 1 and Phase 2 have not yet been connected as intended due to the separate ownership of the sites and should therefore be considered as separate stakeholders.

Based on the 'Lewisham Gateway Phase 2: Sustainability Southern Area Energy Implementation Strategy' developed for Get Living London by Hoare Lea, it is understood that Lewisham Gateway Phase 2 has installed 2 x 140 kWe/212 kWth CHP units, 5 x 1.1 MW gas boilers, and 4 x 8,000 litre thermal stores within their energy centre.

In addition to the above document, existing planning applications DC/15/091742 and DC/18/109819 have been reviewed to determine the site wide energy demand. The key information used in the assessment is summarised in Table 4.

Table 4: Lewisham Gateway data summary

Use	No of dwellings	Gross external area (GEA)	Gross internal area (GIA)	Use type
Phase 1 Residential	362			Residential units
Phase 1 Commercial Floorspace		518 m^2	414 m^2	Restaurant and Retail
Phase 2 Residential	530			Residential units
	119			Co-living units
Phase 2 Commercial Floorspace		4,381 m^2	3504 m^2	Restaurants and retail
		1,606 m^2	1285 m^2	Gym
		2,472 m^2	1978 m^2	Cinema
		1,525 m^2	1220 m^2	Offices

2.2.4 Shopping Centre Redevelopment

SEL and AAL have engaged with several key stakeholders including Landsec (owner and developer of the shopping centre), WSP (energy consultants), Bioregional (sustainability consultants), and Quod (planning consultants). These discussions suggest that the cooling demands on site are deemed insignificant and therefore Landsec are not interested in pursuing an external provision of cooling (i.e. from a source not within the development) from a potential local cooling network. Landsec emphasised that the cooling requirement for the residential elements of the scheme are generally being avoided wherever possible, or else being provided by dwelling-level mechanical ventilation with heat recovery (MVHR) cooling systems where necessary to comply with Part O of building regulations. Landsec advises that the commercial aspects of the scheme have limited cooling demands.

Phase 1 of the development is scheduled to open in late 2028, with heating systems designed to operate independently of the wider DHN. The current plan assumes individual communal networks for each building with air source heat pump (ASHP) units installed on the roofs, however, Landsec understands that the development needs to be heat network ready and therefore the buildings will be future proofed to connect to the Lewisham town centre heat network when it materialises. Depending on the timing of future phases, the buildings could connect to the wider DHN scheme from the outset, avoiding the requirement to install rooftop ASHPs.

The energy demand of the shopping centre redevelopment was modelled based on the information provided by WSP, as shown in the Table 5 below.

Table 5: Shopping Centre Redevelopment data breakdown by phase

	Phase 1	Phase 2	Phase 3	Total
Timing	Before 2028	2028-2032	After 2032	-
No. apartments	1,013	847	819	2,679
Residential area, m^2	72,682	38,929	65,942	177,553
Non-residential area, m^2	3,633	4,342	17,226	25,201
Residential Peak heat, kW	2,300	1,600	2,000	5,200
Residential Annual heat, kWh	2,129,000	1,140,000	1,931,000	5,200,000
Non-residential Peak heat, kW	200	300	900	1,300
Non-residential Annual heat, kWh	88,000	105,000	414,000	607,000

Landsec have stated that the new planning application is due in September 2024, therefore, if there are any significant changes to the design or predicted site demands after the completion of this study, the impact of these changes on the town centre heat network should be evaluated. Landsec are disinclined to host an energy centre serving third parties within their development; and through parallel (anecdotal) conversations, it was discovered that building down (i.e. basement excavation) may be restricted by a flood risk.

Fundamentally, however, Landsec are interested in receiving low-carbon energy from a district heat network, as long as the timeline for the heat network delivery aligns with that of the shopping centre redevelopment, noting that the first occupation in the redevelopment is planned for 2028. Nonetheless, it was emphasised that Landsec do not want to become reliant on an ESCo to set a heat-on date. Landsec also raised concerns about the longevity of the data centre in Lewisham as the only / primary green heat source, although it is noted that WSP had previously explored an aquifer-based heat pump solution that does not appear to feature in the latest design. Landsec was reassured by the incoming Ofgem regulation in respect of heat supply resilience.

2.2.5 Lewisham Metropolitan Police Station

The Lewisham Metropolitan Police Station was contacted but did not engage. Therefore, the key information required for the energy demand assessment was obtained from previous reports and data collected during the feasibility stage. It is understood that the police station is currently supplied by 2 x 600 kW dual fuel boilers; based on operating actual data from 2019 - 2021, the annual demand of the station is circa 2.4 MWh, assuming a gas boiler efficiency of 85%.

The Lewisham Metropolitan Police Station occupies a site financed through the Private Finance Initiative (PFI). PFI is a widely utilised financing mechanism for public infrastructure projects, which has played a vital role in the construction and maintenance of numerous public sector schemes. The Lewisham Metropolitan Police Station PFI agreement is believed to have ended on 28th January 2022, with a requirement to maintain gas boilers for at least 3 years after the PFI ends.

Considering the lack of engagement and the complexities associated with the PFI, Lewisham Metropolitan Police Station has been considered as a potential wider opportunity connection.

2.2.6 University Hospital Lewisham

Lewisham and Greenwich NHS Foundation Trust is the owner of University Hospital Lewisham. The site primarily relies on a steam network supplied by three 4,500 kW steam boilers; a CHP system was installed in 2020 and provides additional heat to the network. The steam boilers are approximately 12 years away from the end of useful life, and therefore Lewisham and Greenwich NHS Foundation Trust has commissioned Llewelyn Davies (architects) to redevelop University Hospital Lewisham during the next 10-15 years, and Troops, Bywaters and Anders (a building services consultancy) to provide technical support for the decarbonisation plan.

University Hospital Lewisham is located approximately 1 km south of Lewisham town centre. Due to the timeline for the planned replacement of the boilers (10-15 years) and the distance from the town centre, it has been considered as a wider opportunity connection. It should also be noted that Equans has a 2016 20-year PFI Hard Facilities Management agreement to deliver services to the Hospital's Riverside building.

Monthly gas usage data from April 2022 to April 2024 was provided by the hospital; Figure 5 illustrates the gas data for 2023 which was used in the heat demand assessment.

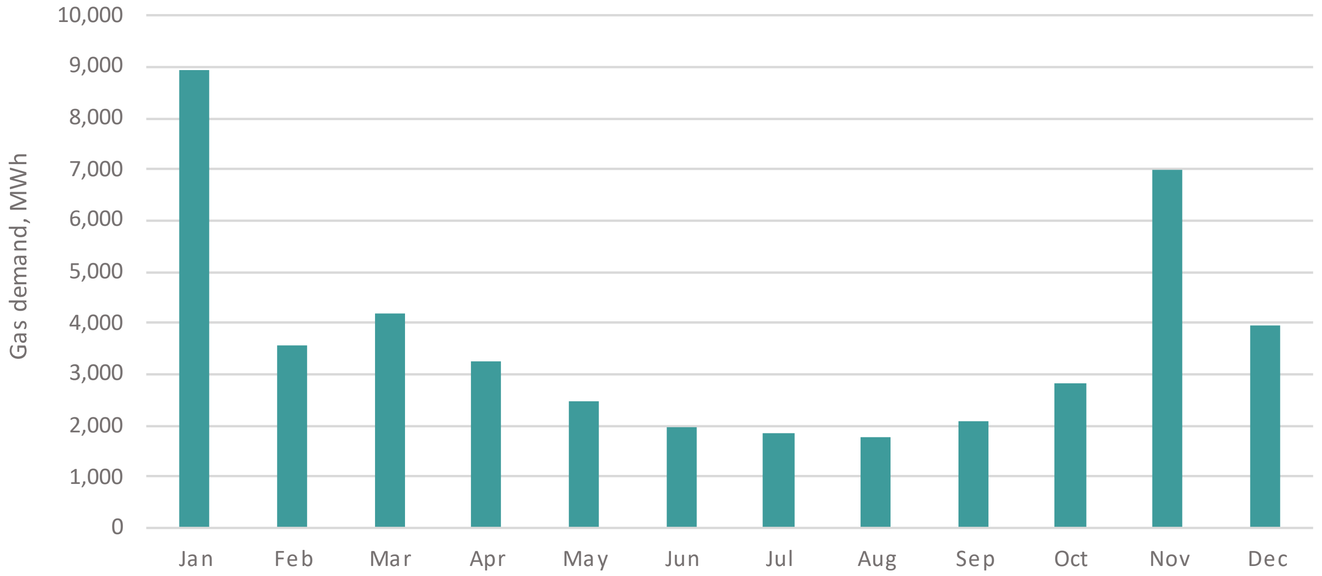


Figure 5: Lewisham Hospital 2023 monthly data

2.2.7 Riverdale Data Centre

Riverdale Data Centre is a potential heat source for the Lewisham town centre heat network. The data centre and the land it sits on are owned by Citibank, which has a 2050 net zero aspiration. Adjacent to the data centre there is an existing combined cooling, heat & power (CCHP) energy centre (as shown in Figure 6), which is owned by EECO Datacentres - a project company owned by Sustainable Development Capital Ltd (SDCL) Energy Efficiency Income Trust (SEEIT) PLC - who would therefore be party to any negotiations.

Figure 6: Data centre and the adjacent CCHP energy centre (Source: Google Earth)

The energy centre is managed by HermeticaBlack, an asset management support company retained by SEEIT, and the energy centre O&M services are provided by Clarke Energy. These asset services contracts are likely to remain in place for the economic life of the engines because they have recently been overhauled (see below), suggesting a sufficient spark-spread value from the gas-based power generation for the data centre.

The existing CCHP plant is owned and operated by EECO Datacentres, and provides electricity and cooling services to the Riverdale Data Centre. The two 1,248 kWe/1,482 kWth CHP engines have been in operation for approximately 10 years and recently underwent a major 60,000 hour service. On average, circa 3 MW of heat is supplied at 91.5°C from the two CHP engines and is used by the absorption chillers to generate 2 MW of cooling at 9°C and circa 5 MW of low-grade heat which is discharged via cooling tower at 35°C. While the energy supply agreement is understood to last until 2030, the lifetime of the CHP plant could potentially extend for another 10 years, or 60,000 hours having completed a major service.

The existing data centre cooling systems are supplied by absorption chillers from the CHP plant, supplemented by rooftop air-cooled chiller plant consisting of 6 units with a capacity of 1.2 MW each. The rooftop chiller plant capacity is sufficient to meet all current cooling demands, but cooling supply from the absorption chillers provides is currently provided at no charge as the site purchases electricity from the CCHP energy centre at the data centre. There are plans to install an additional two 1.2 MW air-cooled chiller units by December 2024 to meet the expanding needs of the data centre.

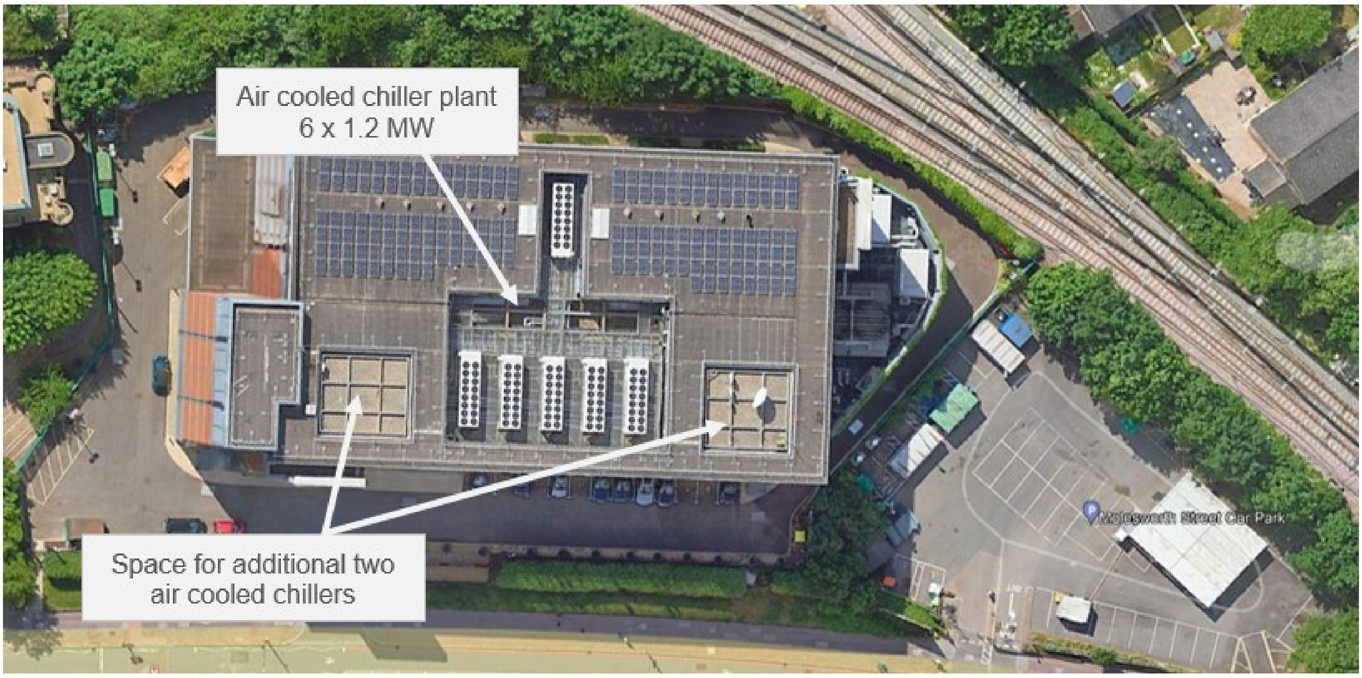


Figure 7: Top view on the data centre (Source: Google Earth)

Currently, 2.5 of the 4 data halls within the data centre have been fitted out; these have a maximum power draw of 4 MW. Citibank has plans to grow the capacity of the data centre and has secured a maximum electrical capacity of 12 MVA, however, reaching full potential of the data centre and utilisation of this maximum capacity will take place over a long timescale.

Citibank is interested in supplying waste heat to the Lewisham town centre heat network as long as the performance of the data centre is not impacted (and therefore there would be no contractual risk to either of the parties). In particular, Citibank is concerned with ensuring that the data centre cooling facility is as reliable as possible and so wished to retain control of their cooling systems, which was linked to their resilience duties under regulatory requirements.

Citibank owns the building and its freehold outright, and so there are no issues with long term energy agreements.

Sustainable Development Capital Limited (SDCL)

AAL and SEL reached out to SDCL to gauge their interest in becoming an ESCo and/or investing in the scheme. SDCL are looking at Energy Co long term investment models and confirmed that they would like to see letters of support for the heat network, and could provide their own (pending sight of the Techno-economic Model (TEM)).

To receive funding from the GLA and SDCL partnered EDGE fund, the heat network would need a fast lead time as the fund has a two-year investment period, therefore this fund may not be suitable.

2.3 Stakeholder Risks

Table 6 below outlines the most significant stakeholder-related risks identified; these risks will need to be considered as the project progresses.

Table 6: Stakeholder Risks

Risk	Description
Molesworth Street Car Park (explored in detail later)	Molesworth Street Car Park has been identified as the preferred energy centre location due to its size, proximity to the data centre and the fact that the Council has a freehold on the land. However, TfL has a Title Restriction on the land that relates to the Bakerloo Line Extension bus stand safeguarding plans. Discussion with TfL revealed that Molesworth Street Car Park is the only viable location (although not ideal) for the bus stand
Limited / constrained grid capacity	Citibank has received permission to reserve 12 MVa of grid capacity, which could be a potential issue given the need to decarbonise existing and future nearby developments i.e. the need to electrify existing CHP gas-powered services. This is further complicated by the fact that it is highly likely that TfL will want to station and charge electric buses adjacent to the data centre. These competing commercial interests may be difficult to align
Viable heat source	The date centre has been identified as the most viable primary green heat source with sufficient capacity to supply a network. In the unlikely event that Citibank moves its data centre operations outside of Lewisham, this would have a significant impact on the scheme.
Timing	The exact phasing of the scheme is an important consideration as a number of stakeholders (notably Landsec) raised concerns about the setting of heat-on dates by an ESCo which did not align with their development timelines
Existing commercial contracts	There is currently an asset services contract in place between HermeticaBlack and Clarke Energy for the existing CCHP energy centre (adjacent to the data centre) that is likely to remain in place throughout the economic life of the engines. The engines have recently been overhauled, suggesting a sufficient spark-spread value from the gas-based power generation

Risk	Description
Uncertain development plans	There are a number of developments and redevelopments currently underway, including Lewisham Gateway Phase 2, Lewisham shopping centre, Lewisham retail park and University Hospital Lewisham. Some of these developments are currently (or will be) negotiating with Lewisham planning department, and hence there is a significant degree of uncertainty about how these developments will unfold. Note that despite this uncertainty, these developments will have to be heat network ready (as set out in recent Heat Network Zoning legislation).

2.4 Stakeholder Engagement Summary

Figure 8 summarises each stakeholder's interest and influence in the scheme. Where a stakeholder has been deemed to have high interest and influence, a letter of support has been shared for their signature (for more information on this see the accompanying Commercial Case).

Note Citibank's high interest is conditional on cooling resilience, and Landsec's high interest is conditional on heat-on timing.

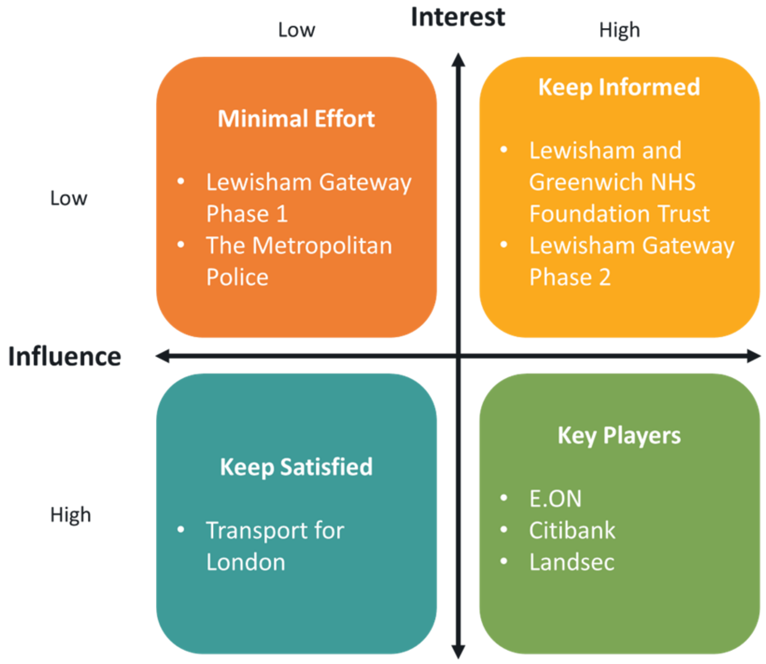


Figure 8: Mendelow's interest / influence matrix

3 ENERGY DEMAND ASSESSMENT

Following the data collection exercise, energy demands were assessed for all sites identified as potential connections within the assessment area.

3.1 Energy Demand Profiles

Energy demands for potential network connections have been reviewed, verified, and updated where required. This process included the issue of requests for information (RFIs) to all key stakeholders. Actual data was used wherever possible.

In cases where half-hourly/hourly data was unavailable, best practice as outlined in Objective 2.2 of the CIBSE / ADE Heat Networks Code of Practice was followed (to achieve sufficient accuracy of peak heat demands and annual heat consumptions) and comply with the Future Home Standard Part L of the Building Regulations.

Hourly profiles for heating and domestic hot water demand were modelled using SEL's in-house software. The software apportions demands to hourly loads over the year, normalised against degree day data from the nearest monitoring station (in this case London City Airport). The hourly profiles consider building use and occupancy, site measurements, construction details, and operating parameters. For residential energy demands, the hourly profiles were derived from data sets of actual hourly heat demand data for similar residential buildings, collated from SEL's network management dashboard.

From these profiles, the peak, baseload, seasonal, and annual heat demands of each potential network connection were identified.

University Hospital Lewisham

The average, minimum, and summer heat demand graph for the University Hospital Lewisham is shown in Figure 9.

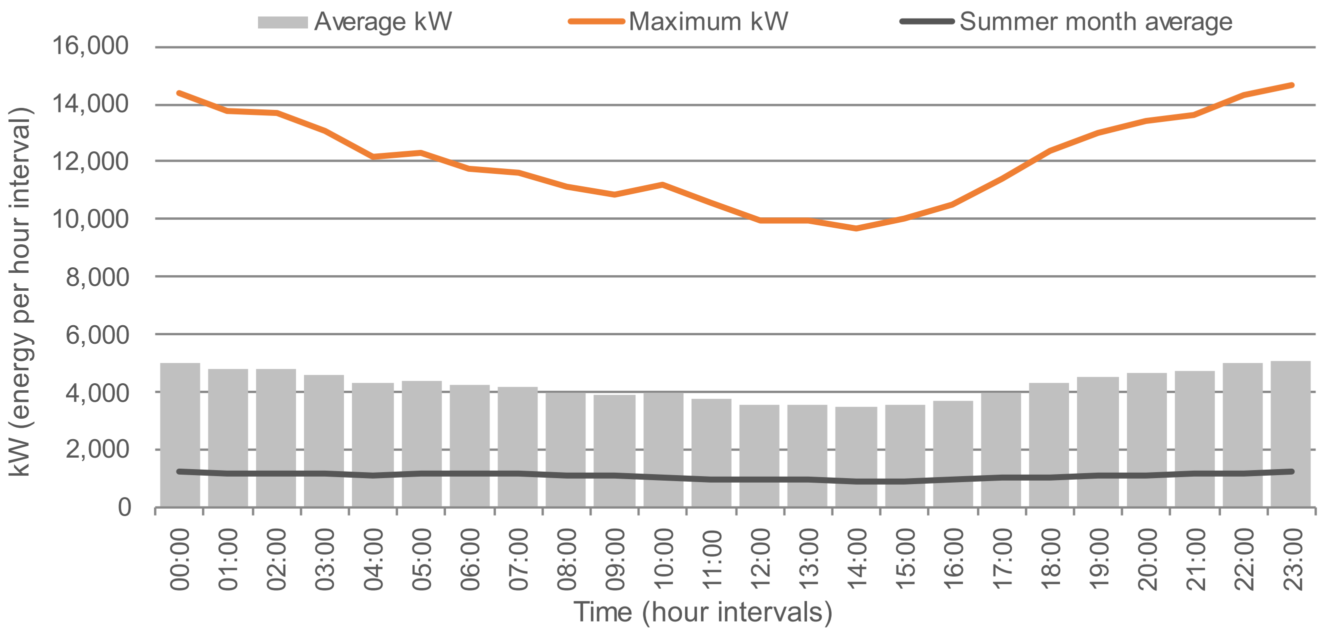


Figure 9: University Hospital Lewisham average, maximum, and summer average heat demand graph

E.ON Heat Network

The average, minimum, and summer average heat demand graph for the E.ON Heat Network is shown in Figure 10.

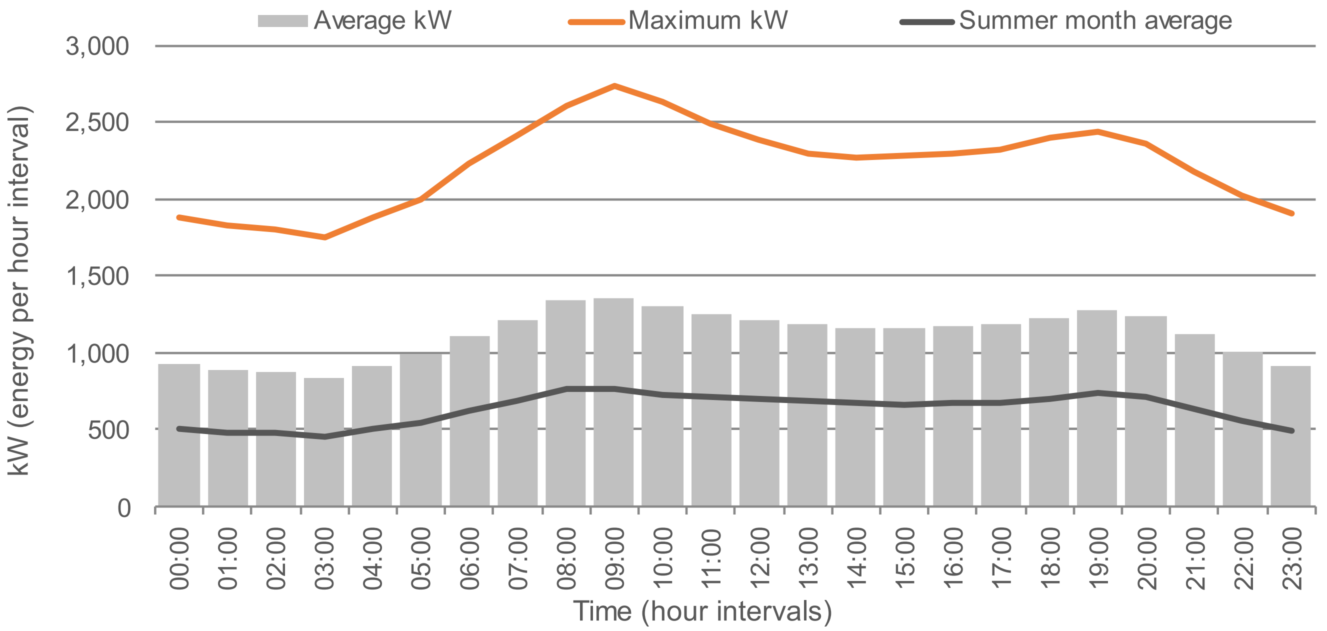


Figure 10: E.ON Heat Network average, maximum, and summer average heat demand graph

Shopping Centre Redevelopment

The average, minimum, and summer average heat demand graph for the Shopping Centre Redevelopment is shown in Figure 11.

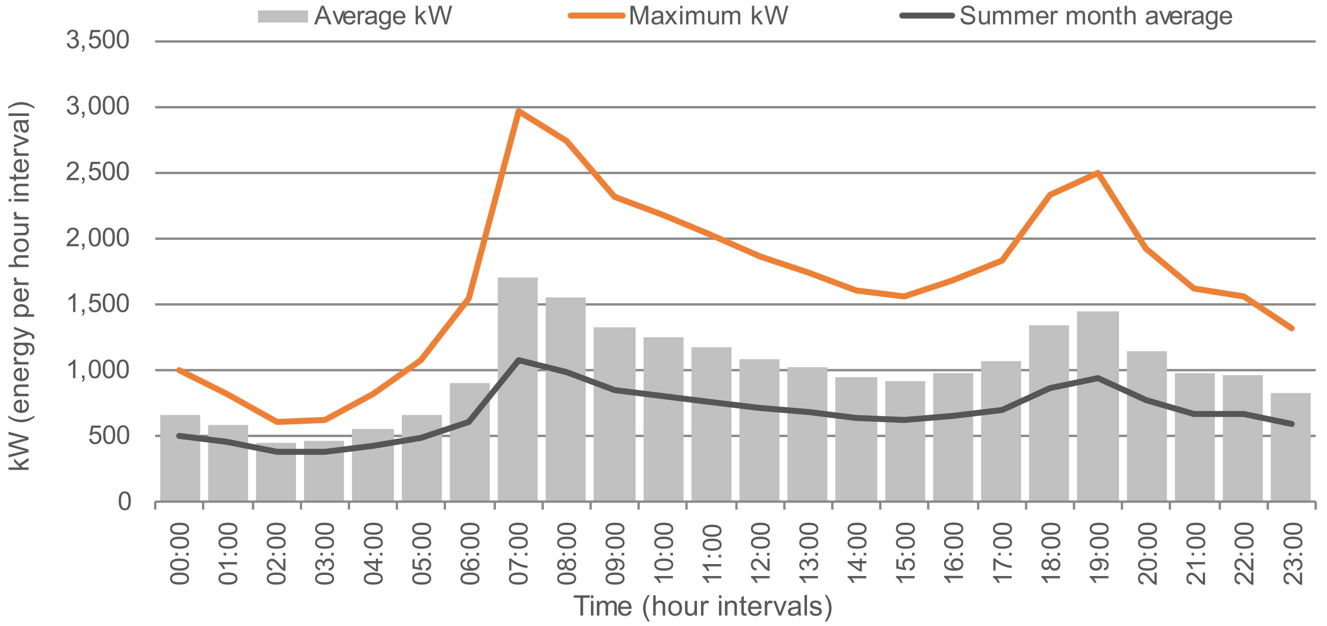


Figure 11: Shopping Centre Redevelopment average, maximum, and summer average heat demand graph

Lewisham Met Police Station

The average, minimum, and summer heat demand graph for the Lewisham Met Police Station is shown in Figure 12.

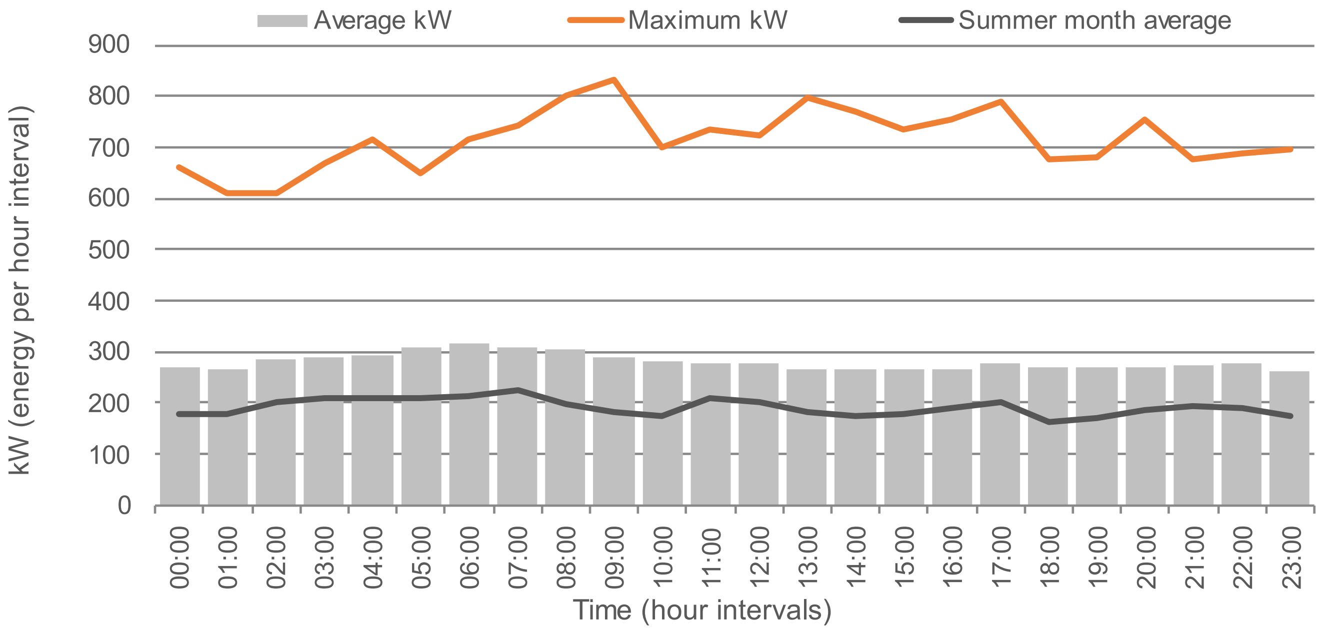


Figure 12: Lewisham Met Police Station average, maximum, and summer average heat demand graph

Lewisham Gateway Phase 1

The average, minimum, and summer average heat demand graph for the Lewisham Gateway Phase 1 is shown in Figure 13.

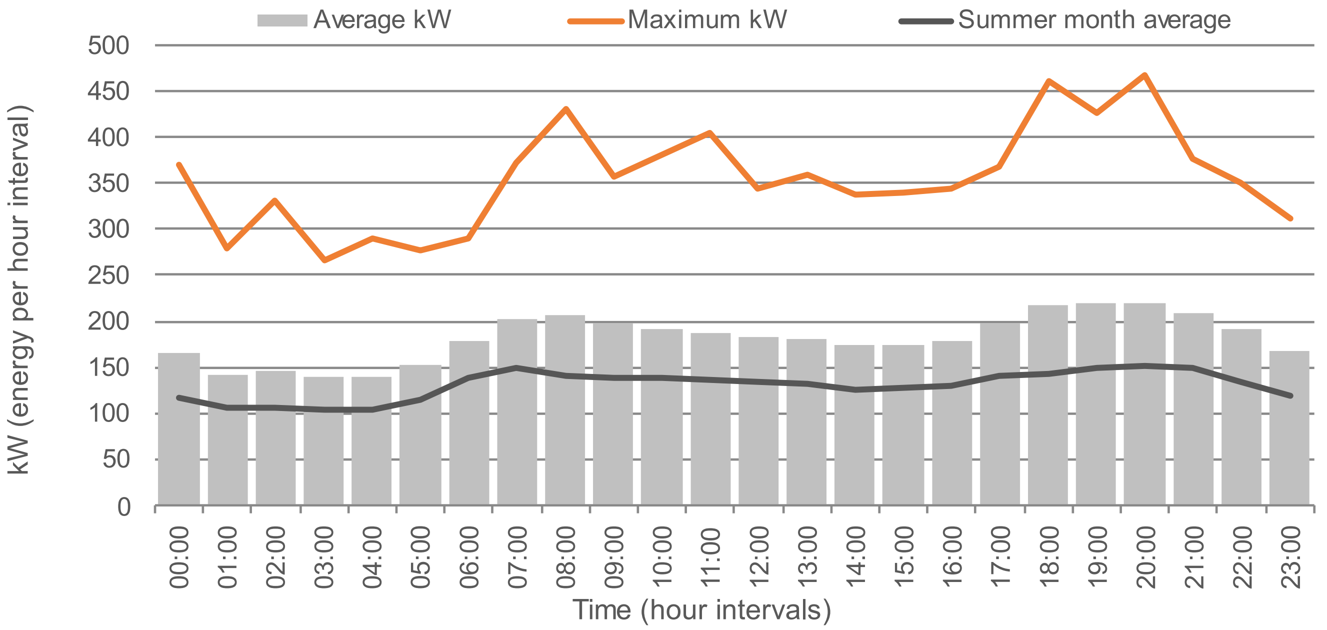


Figure 13: Lewisham Gateway Phase 1 average, maximum, and summer average heat demand graph

Lewisham Gateway Phase 2

The average, minimum, and summer average heat demand graph for the Lewisham Gateway Phase 2 is shown in Figure 14.

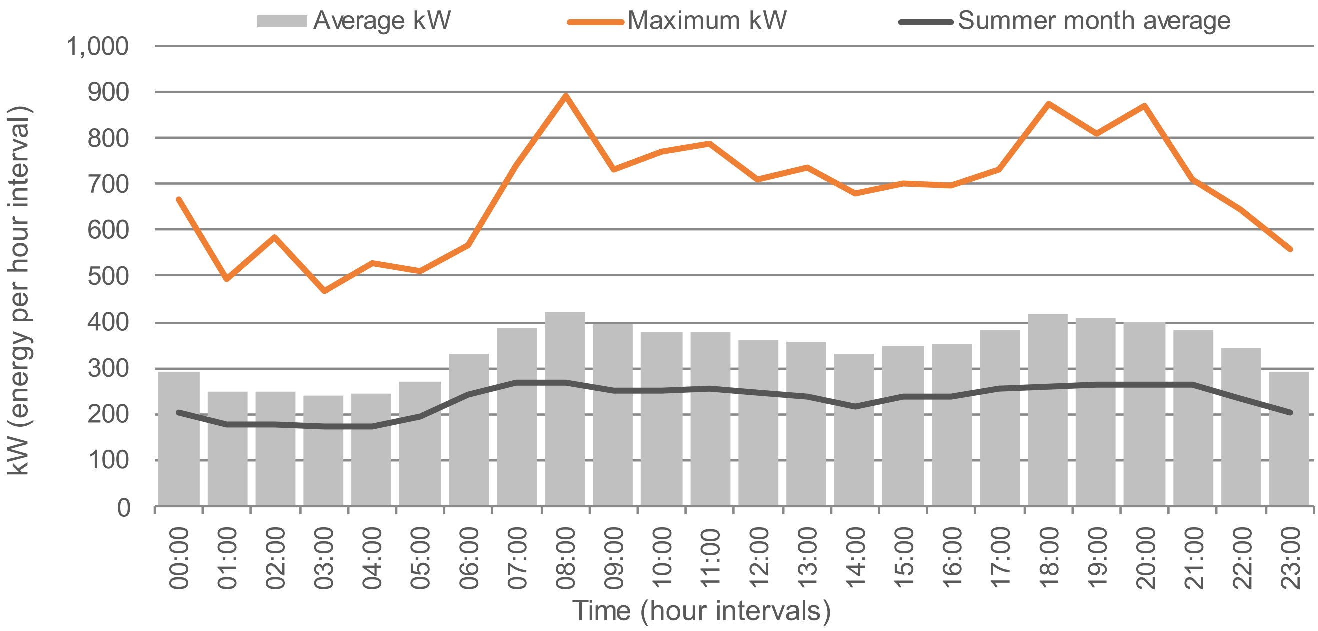


Figure 14: Lewisham Gateway Phase 2 average, maximum, and summer average heat demand graph

Lewisham Retail Park Development

The average, minimum, and summer average heat demand graph for the Lewisham Retail Park Development is shown in Figure 15.

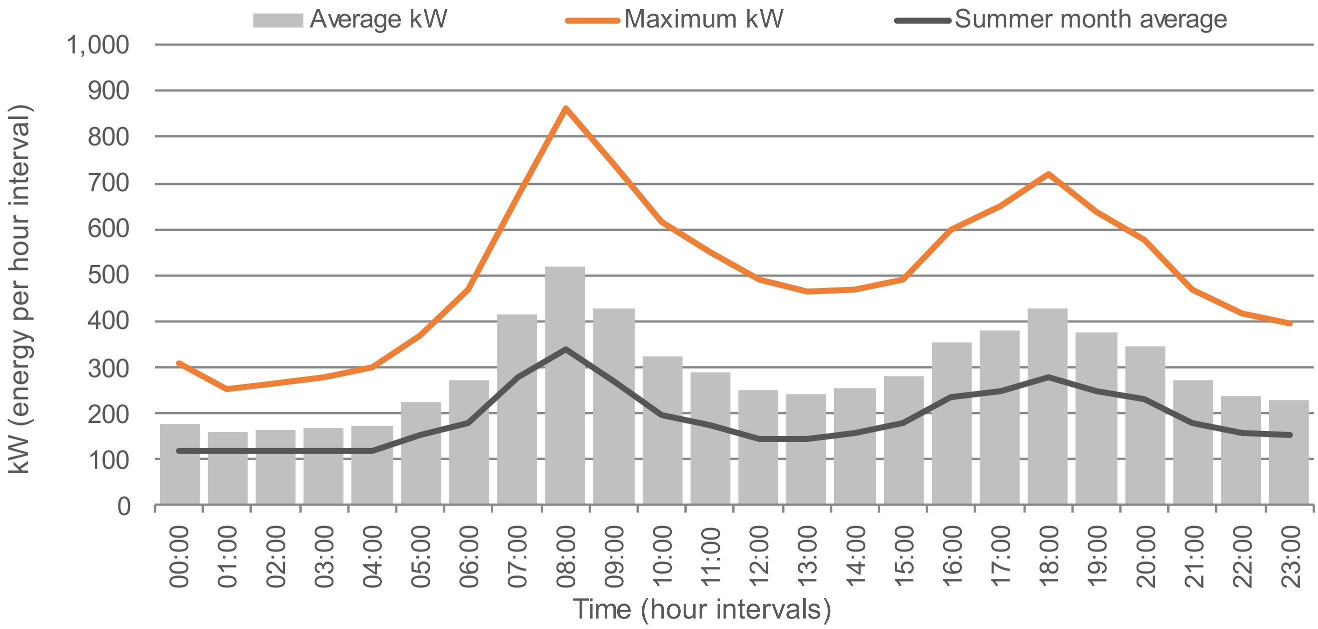


Figure 15: Lewisham Retail Park Development average, maximum, and summer average heat demand graph

Prendergast Vale School

The average, minimum, and summer average heat demand graph for the Prendergast Vale School is shown in Figure 16.

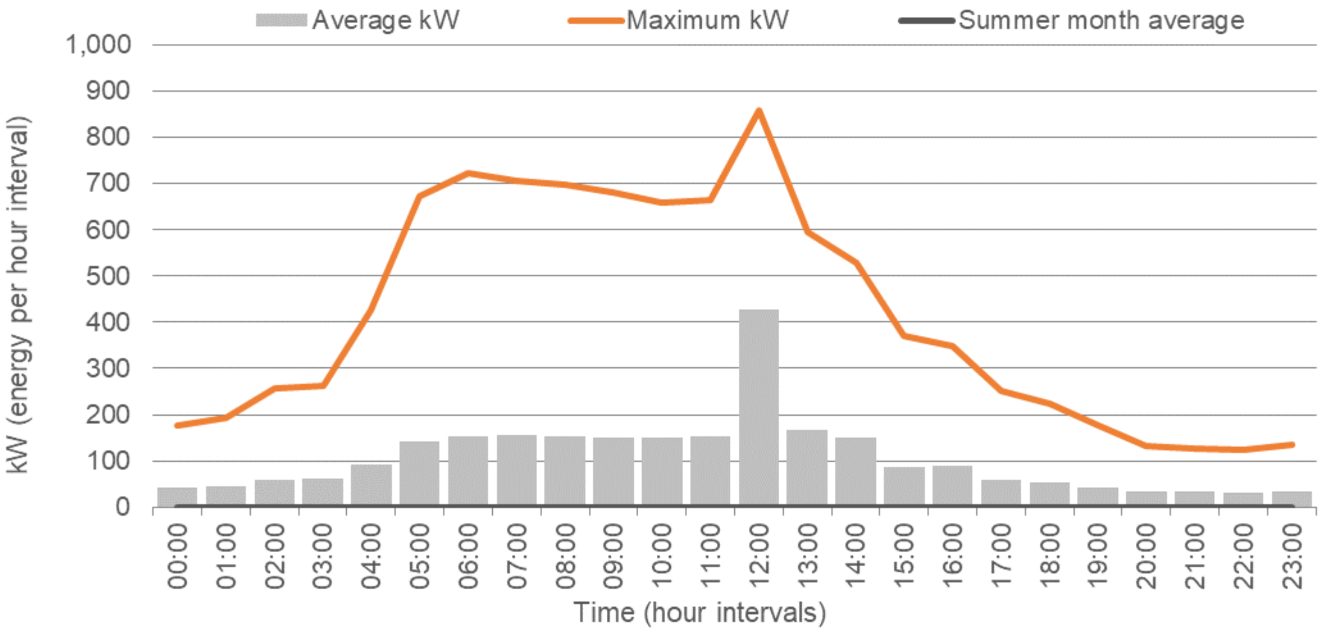


Figure 16: Prendergast Vale School average, maximum, and summer average heat demand graph

3.2 Energy Demand Assessment Results

Geographic Information System (GIS) software was used to map the identified annual heat demands. The total heat demand of the assessed sites was 66,275 MWh. The heat demands for all sites assessed are shown in Figure 17 and Table 7, where they are ordered from highest to lowest. The largest heat demand arises from the University Hospital Lewisham (37,218 MWh).

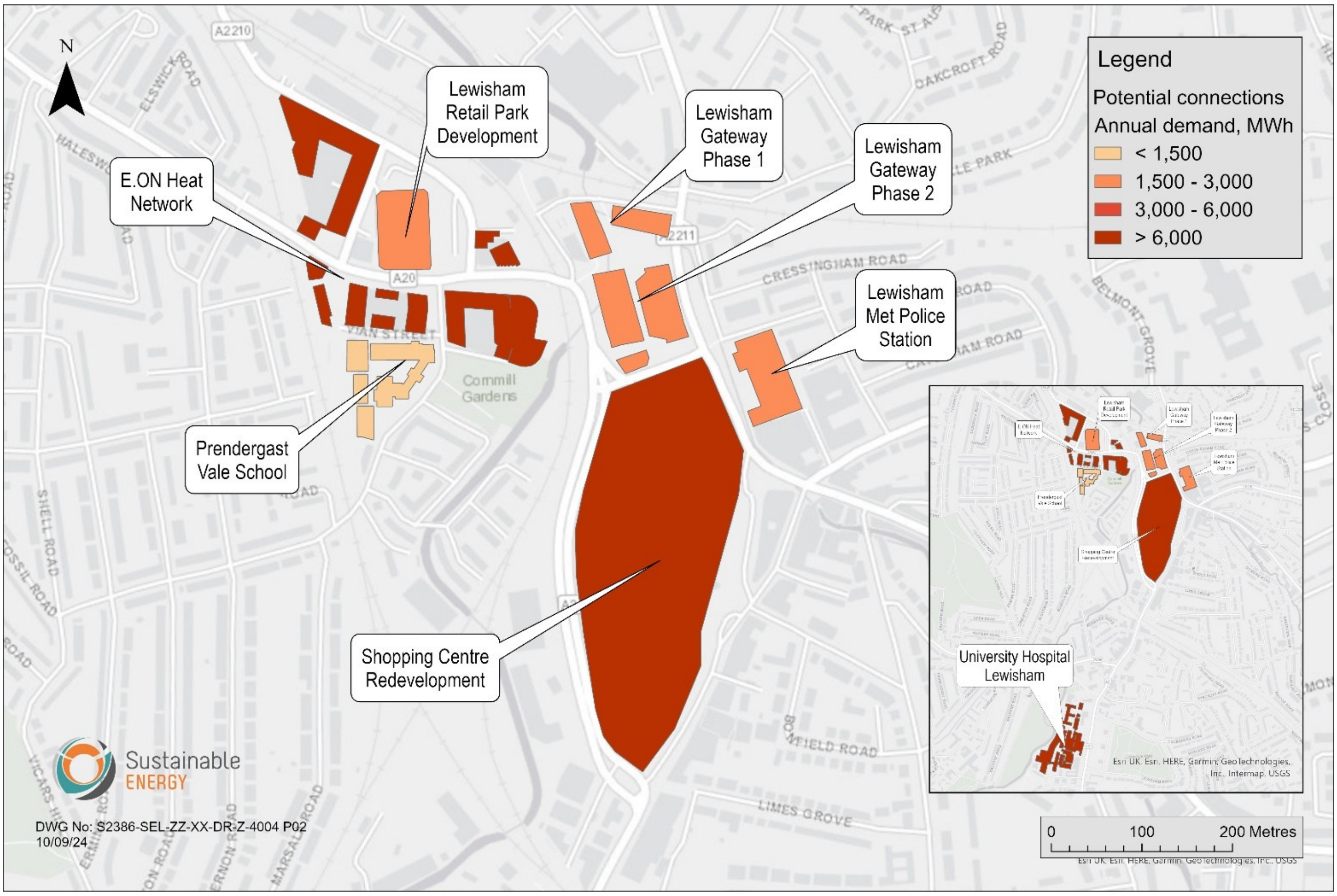


Figure 17: Heat demands of key stakeholders

Table 7 quantifies the annual heat demands arranged from the highest to lowest, and the data sources. These heat demands include the distribution losses throughout the building where applicable.

Table 7: Heat demands of key stakeholders

Rank	Name	Status	Ownership	Peak demand, kW	Annual heat demand, MWh	Source of data
1	University Hospital Lewisham	Existing	NHS	14,678	37,224	Actual data (metered monthly)
2	E.ON Heat Network	Existing	Private sector	2,740	9,818	Actual data (metered hourly)
3	Shopping Centre Redevelopment	Planned development	Private sector	2,971	8,713	Energy demand model
4	Lewisham Met Police Station	Existing	Other public sector	835	2,459	Actual data (metered hourly)
5	Lewisham Gateway Phase 2	Existing	Private sector	892	2,997	Energy demand model
6	Lewisham Retail Park Development	Planned development	Private sector	864	2,531	Energy demand model
7	Lewisham Gateway Phase 1	Existing	Private sector	467	1,592	Energy demand model
8	Prendergast Vale School	Existing	Lewisham Council	859	940	Actual data (DEC)

3.3 Summary

Heat Network Zoning will come into effect in the next few years (expected in 2025) with the Government and DESNZ already committing to Advanced Zoning Pilot and the delivery of Heat Network Legislation in the Energy Security Act (2023). It is anticipated that the Lewisham area will be identified as one of the zones in London subject to new heat network zoning regulations.

Current policy guidance would require buildings currently connected to an existing heat network (i.e. E.ON network connections, Gateway 1 & 2), including the existing communal networks, existing buildings with large heat consumption and new developments (i.e. Retail Park Development & Shopping Centre Redevelopment) would also be required to connect.

Table 8 summarises the results of the energy demand assessment. This shows that 81% of the total heat demand is based on actual data, both metered and DEC, and only 19% has been derived from energy demand models.

Table 8: Summary of energy demand data sources

	Total heat demand, MWh	Actual data	Based on data from energy demand models
Heat demand	66,275	72%	28%
		47,981 MWh	18,293 MWh

4 HEAT SUPPLY ASSESSMENT

Potential low carbon and renewable energy sources that are within Lewisham Town Centre area were assessed to identify any that may have the potential to supply a heat network.

4.1 Long List Options

A long list appraisal was undertaken of all potential low carbon heat sources to supply a heat network in Lewisham Town Centre and is summarised in Figure 18 and Table 9.

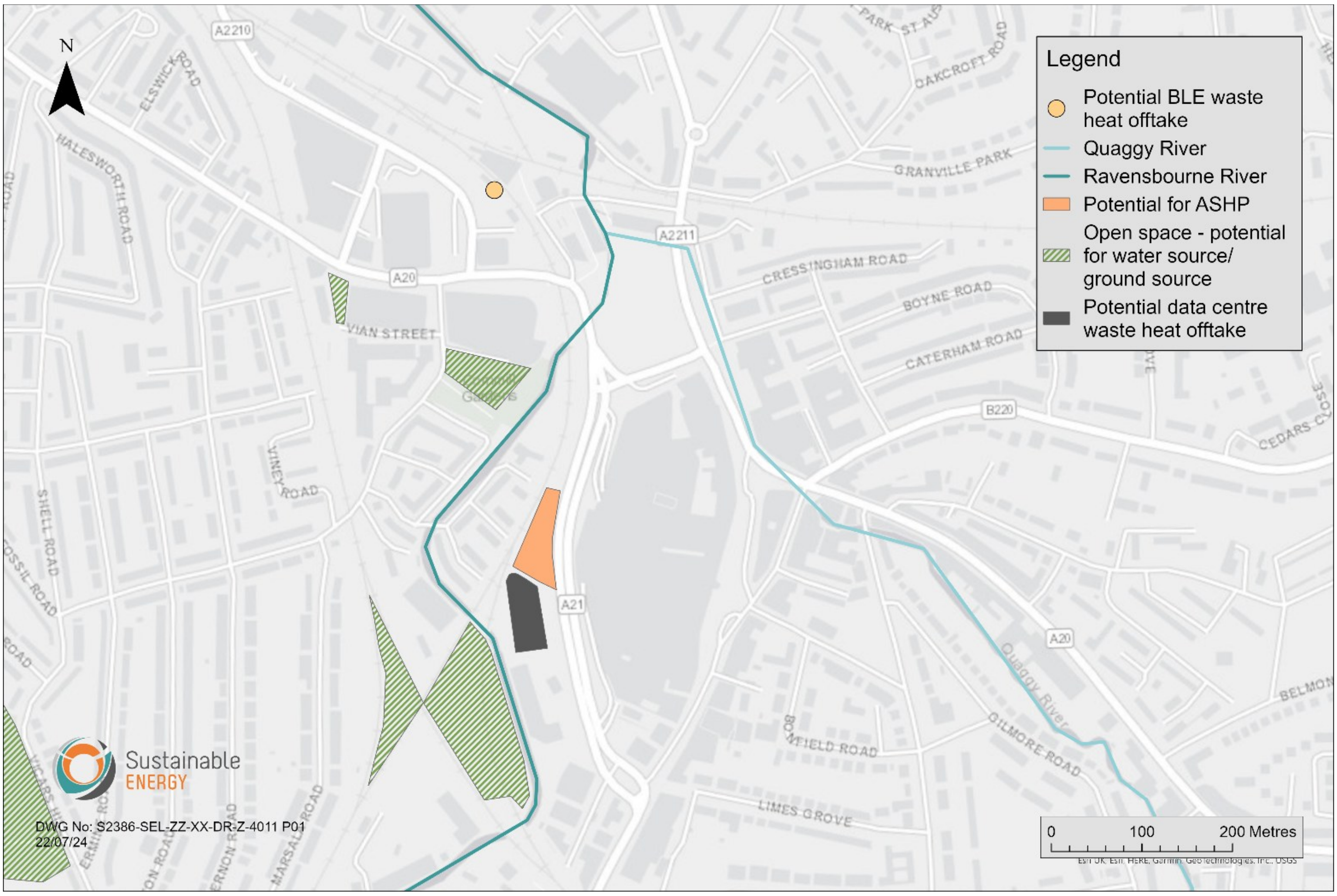


Figure 18: Potential heat sources

Table 9: Summary of potential heat sources

Technology		High level technical viability considerations	Considered further?
Open loop heat pump	River water source heat pump (WSHP)	• The Quaggy and Ravensbourne Rivers pass through Lewisham • The combined mean river flow rate of both rivers is approximately 0.5 m³/s which is insufficient to supply capacity required by the town centre heat demands • Unknow flow temperatures and inconsistent water level throughout the year (water level could drop below 0.5 m)	No, due to low flow rate and varying water levels
	Mine WSHP	• No previous mine workings in the area	No, due to no previous workings

Technology		High level technical viability considerations	Considered further?
	Wastewater WSHP	• No waste water works in the area • Potential to utilise sewers to serve waste WSHPs, however, unlikely to be sufficient capacity to serve the town centre heat demands • Commercially complex and high capital cost solution	No, due to no existing works
	Aquifer WSHP	• Green space available for borehole drilling at Cornmill Gardens, courtyard adjacent to E.ON energy centre, and between the railway and Ravensbourne River • Local energy project experience within 2 km suggests yields of 20 l/s • Abstraction and reinjection boreholes would be required, spaced 200 m apart with an ambient pipe in between • Chalk aquifers are normally stable geological structures offering reliability and longevity once the borehole infrastructure is in place • Chalk aquifers offer a fairly stable temperature throughout the year that are not impacted by seasonal temperature fluctuations and so may perform more efficiently during cold winter periods than other heat pump technologies • Test borehole will be required to confirm ground water availability • Lower operating cost due to higher COP in comparison to ASHP	Yes
Waste heat offtake		• Riverdale Data Centre is located in the town centre area, with its own energy centre which currently includes CHP plant & absorption chillers supplemented by a rooftop air-cooled chiller plant • Approximately 5.4 MW of constant low-grade heat is discharged from the cooling tower at 35°C • Citibank has plans to expand the data centre capacity, increasing the waste heat resource and potentially enabling network expansion	Yes
Centralised air source heat pump (ASHP)		• Molesworth Car Park is a potential location • Potentially lower initial CAPEX than WSHP, however higher operating costs due to lower CoP • Significant space requirement for air heat exchangers • Not dependent on accessing ground or open water • ASHP at a large scale may have a cooling effect on the local environment	Yes
Individual building ASHPs		• Space required at each building or network of buildings for heat pumps and their respective air to water heat exchangers • Visual and noise impacts local to the heat pump positions	No

Technology	High level technical viability considerations	Considered further?
	• Lower performance for smaller heat pumps compared to larger scale industrial heat pumps • Lower performance from air source compared to data centre heat • Heat demand is not diversified, and significantly greater heat pump capacity required • Higher capacity electricity connections are required for each building and may result in significant grid reinforcement costs	
Closed loop ground source heat pump (GSHP)	• Requires a large area of land for borefield, which may be available at Cornmill Gardens but would require significant civils works to connect all boreholes and will be disruptive for the local community • Significant number of boreholes to provide heat capacity required by the town centre demands, • High number of boreholes will mean significant drilling and interconnecting pipes and manifolds would be needed to supply closed loop • May have a cooling effect on local ground condition if not designed correctly	No, due to space requirements
Biomass CHP	• Air quality and smoke control zones limit opportunities for biomass within town centres • High cost of fuel compared to mains gas • Larger space requirements compared to other heat sources because of solid fuel delivery and storage • Frequency of fuel deliveries, and congestion issues that this may cause • Would require a sustainable source of fuel to be considered low carbon	No, due to limited space available, air quality and economic viability
Energy from waste (EfW)	• No existing or planned energy from waste plants in proximity to the assessment area	No, as no sites near assessment area
Other heat networks	• At the time of this study there are no existing heat networks within feasible distance, however there may be future large-scale networks stretching from Southwark (SELCHP Heat Network) or Bexley (Riverside Heat Network)	No, but has potential to supply wider opportunity demands
Gas CHP	• Potentially improved economic viability achieved through private wire sales, where sufficient electrical demand is present • Existing CHP plants could be incorporated into early network phases • Air quality issues, however, abatement measures likely to be viable	No new CHP but existing CHP plants can be used

Technology	High level technical viability considerations	Considered further?
	• Higher carbon emissions compared to some other technologies so should be regarded as an interim option alongside heat pump only • Not eligible for Green Heat Network Fund (GHNF)	
Gas boilers	• High CO_2e • Potentially lower OPEX than electric boilers (lower fuel costs) • Considered as potential back up and peak only • New boilers not allowed by London Plan • Potential to use peak & reserve boilers installed at E.ONs energy centre and Lewisham Gateway	Considered only as a potential supply from existing networks to provide peak and reserve heat to the town centre network
Electric boilers	• Expensive if used during peak electricity usage times • Low upfront CAPEX to install • Possible price reduction per kWh in future • High grid connection costs • Considered as potential back up and peak only	Yes, as peak and reserve boilers
Heat offtake from Bakerloo line extension (BLE)	• Potential to utilise the heat generated by trains and trapped in the underground network, this concept has been demonstrated on the Bunhill scheme in Islington • Would rely on the Bakerloo extension being underground through Lewisham Station • Currently planned to be constructed by 2039	No
Solar thermal	• Significant land required for collector arrays • Significant initial capital costs • Low operating costs per kWh • Disconnect between seasonal times of generation and demand	No, as no space available near key heat demands

4.2 Short Listed Options

The following options have been shortlisted based on a viability assessment as well as an analysis of risk, benefits and disbenefits:

- Aquifer WSHP
- Centralised ASHP
- Waste heat offtake from Riverdale Data Centre

Electric boilers have been considered only as peak and reserve options, while CHP and gas boilers are considered only as a potential supply option utilising existing networks to provide peak and reserve supply.

All of the shortlisted options have the potential to meet the CSFs, however, the waste heat offtake from Riverdale Data Centre is most likely to offer the highest heat source temperatures. This will result in the highest efficiency and potentially the lowest heat sale tariffs and lowest carbon intensity, meeting the key CSFs. Waste heat offtake from Riverdale Data Centre also has the potential to supply a wider town centre area; circa 5 MW of low-grade heat could be diverted from the cooling towers, and in the future, the rooftop air chillers could provide additional heat offtake capacity.

Therefore, heat pumps with the heat source of waste heat offtake from Riverdale Data Centre is taken forward as the preferred option. However, there are a number of different ways/points that the heat can be taken, which will impact the performance of the heat pump, these are investigated and compared in section 4.3.

4.3 Preferred Option Assessment

Data centre heat offtake opportunities will vary over time as the existing data centre cooling systems are supplied by absorption chillers from a CHP plant, supplemented by a conventional rooftop air cooled chiller plant. Future growth of the data centre should include cooling technology that can accommodate the heat offtake opportunity when the CHP plant is retired at end of life or as part of carbon reduction priorities. The following sections describe how heat offtake could be configured and the associated benefits.

To effectively compare the potential heat offtake options and assess the impact of offtake source temperature on heat pump efficiency, a consistent heat pump efficiency calculation was used across all options. It was assumed that the heat pump would have a Lorenz efficiency of 43% (typical of a multi-MW heat pump operation) and would provide heat network temperatures of 75°C/55°C for flow and return respectively. The Coefficient of Performance (COP) of the heat pump was then calculated to allow for a direct, like for like comparison across the different offtake options.

4.3.1 Short Term Option – Before Gas CHP engines are removed

The heat available from the CHP/absorption chiller plant will be extracted before reaching the cooling towers, with a flow temperature of approximately 35°C. Assuming a Lorenz efficiency of 43%, a coefficient of performance (COP) of 4.5 was calculated from utilising the absorption chillers under a heat network temperature condition of 75/55°C.

The schematic in Figure 19 illustrates the heat offtake position and potential arrangement of the off-site heat pump energy centre, required to raise the temperatures for the town centre heat network. External heat exchangers could also be included to provide back up/additional heat supply from ambient air.

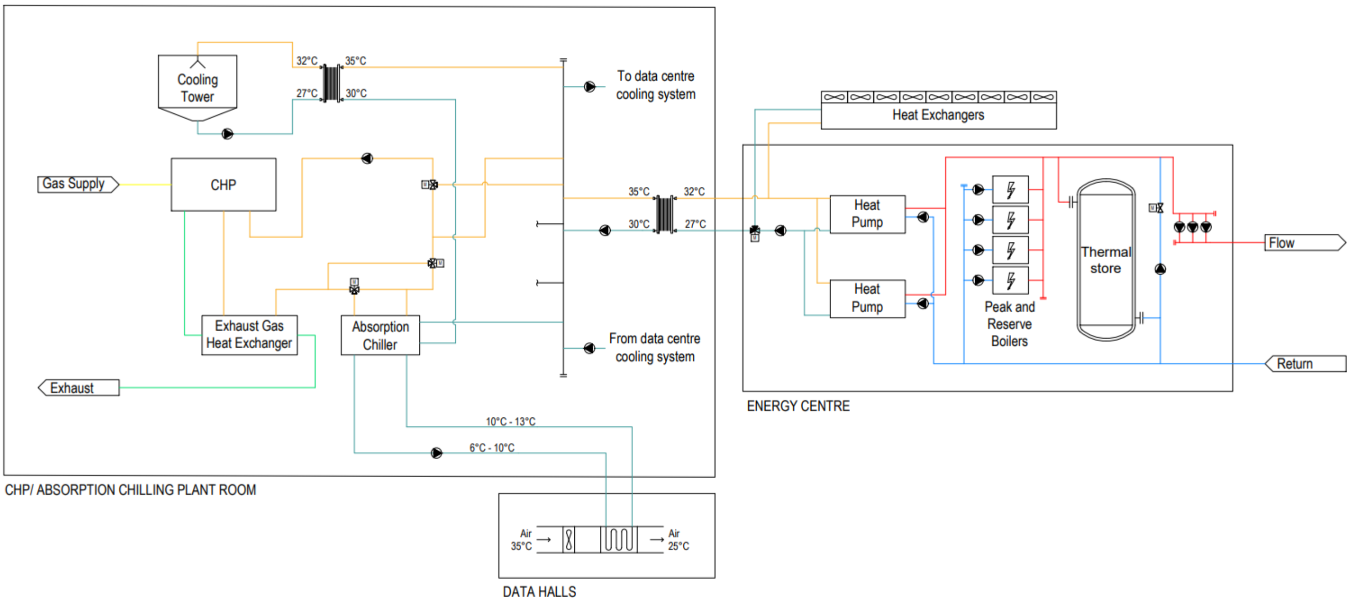


Figure 19: Data centre heat offtake - Short term option 1

This solution has no risks associated with integration with the data centre as it diverts the waste heat from the cooling towers on the EECO Datacentres side of the system. No modifications are made to the data halls or cooling systems within the data centre.

However, the commercial timeframe of how long this heat will be available will depend on the remaining lifetime of the CHP engines and absorption chillers (expected to be circa 10 years) or the conclusion of the contract which may be influenced by energy prices (spark gap) or Citibank's carbon reduction targets.

4.3.2 Short Term Option – Following removal of CHP engines

Following removal of the CHP engines from service, there is an option to continue to supply cooling to the data centre from heat pumps run at lower source side temperatures.

In this scenario, the return water from the cooling circuits within the data halls would serve as the heat source for the heat pump. The design temperature was initially set at 9°C, however on-site data collection confirmed that the actual source temperature could be as high as 13°C. With a Lorenz efficiency of 43%, the calculated heat pump COP would be 2.7. Figure 20 illustrates the heat offtake arrangement for the short-term option following CHP removal.

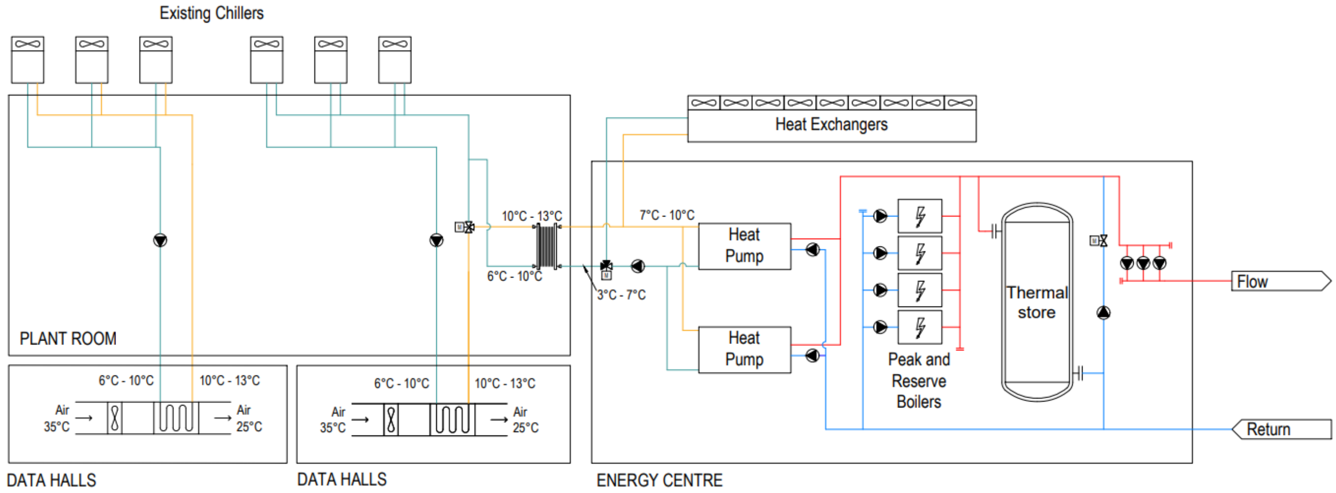


Figure 20: Data centre heat offtake - Short term option 2

This operating case would provide a benefit to the data centre in terms of cooling energy supply and therefore, a cooling fee could be charged which would compensate for the lower COP of the heat pumps.

The current arrangement is that the 2 x CHP engines and absorption chillers provide electricity and cooling to Citibank, but the commercial agreements do not include charging for cooling supply on a per unit basis to Citibank.

4.3.3 Longer Term Option – Heat recovery from chillers

It is understood that the data centre has secured additional electrical capacity to further develop the site. This electrical capacity could allow the installation of additional data halls which could offer a greater level of heat offtake in the future. Any future growth should consider new chillers which incorporate heat recovery which would be able to provide a higher grade of heat to a heat network energy centre. Also, when the existing chillers reach end of life, the opportunity will be presented to replace them with new heat recovery chillers.

In this case the temperature of heat recovered from new chillers could be as high as circa 35°C. Assuming a Lorenz efficiency of 43% and heat network temperature conditions of 75/55°C, the data centre heat offtake would increase the heat pump COP to 4.5 for waste heat recovery.

The commercial considerations should address that new heat recovery chillers could have higher capital costs than existing like-for-like or free cooling chillers.

A schematic of the proposed integration in this configuration is shown below:

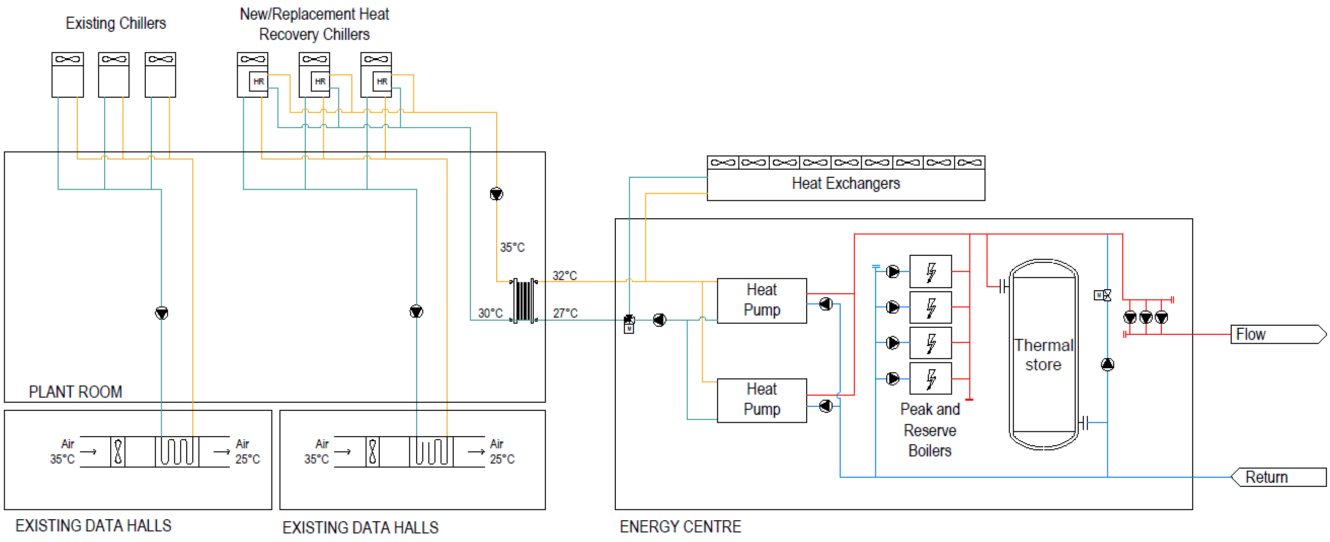


Figure 21: Data centre heat offtake - Longer term option 1

4.3.4 Longer Term Option 2 – Data halls heat recovery option

As the data centre develops the site further, additional data halls could be fitted with heat offtake from the cooling air this option would require new data hall to be fitted with heat exchangers which could incorporate heat recovery. This approach would provide greater level of heat offtake capacity available.

In this case, the heat recovery circuits from the data halls, based on the current operating conditions, could provide offtake temperature of circa 35°C to 30°C, slightly lower than the temperatures available from the chiller heat recovery system. It's worth noting that this solution could be also applied to existing data halls. Based on a Lorenz efficiency of 43% and under heat network temperature condition of 75/55°C, the heat pump COP would be between 4.5 and 3.9 depending on the quantity of heat offtake from data halls and chillers.

An example of data hall heat offtake is shown in figure below:

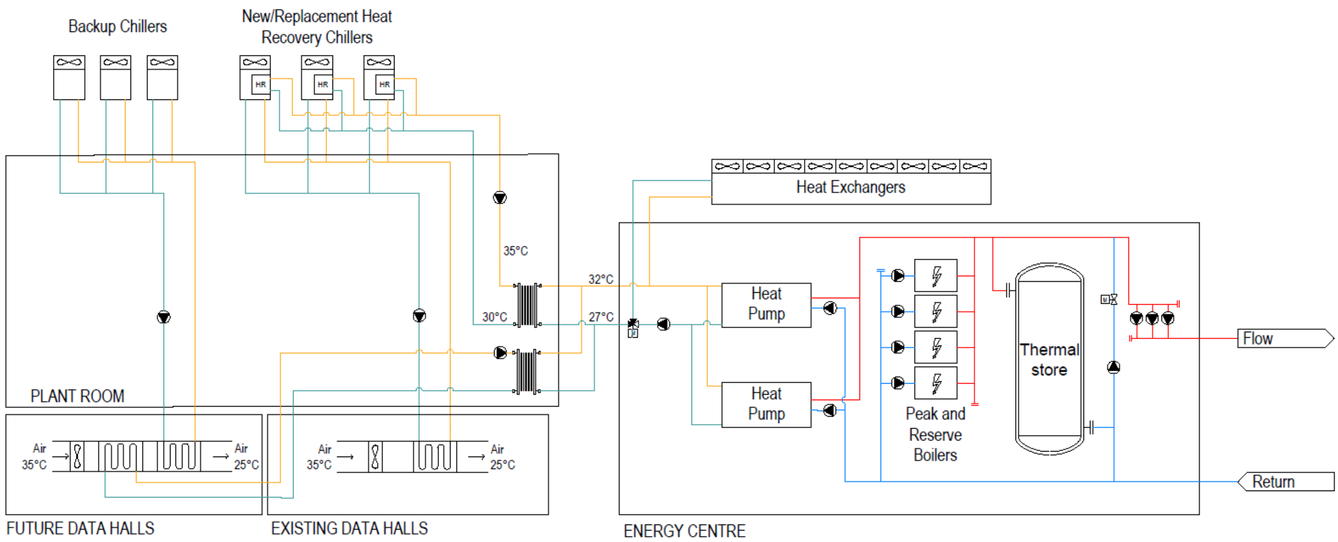


Figure 22: Data centre heat offtake - Long term option 2

New data halls with heat recovery from the extract air may not be viable or may incur higher capital costs compared to the existing design of the data hall air cooling systems. Implementing this solution which incorporates heat exchangers into the air ducts within the data halls might not be feasible given the current design and construction of the data centre. Also the boundary of equipment ownership would need careful consideration, particularly with regards to determining who would own the heat exchange coils within the system.

4.4 Summary

A summary of the potential heat offtake options is shown below; all options assume a heat pump Lorenz efficiency of 43% and heat network temperatures of 75/55°C.

Table 10: Summary of potential data centre heat offtake options

Option	Heat source	Potential heat offtake capacity and COP
Short term option 1	Heat offtake from the CHP/absorption chiller plant Source temperature: ~35°C	3 MW available at COP: 4.5 Low grade offtake from CHP/absorption chiller
Short term option 2	Heat offtake from the cooling circuits within the data halls (following removal of the CHP plant) Source temperature: ~13°C	3 MW available at COP: 2.7 Pre-cooling for existing chiller circuit
Longer term option 1	Heat offtake from new heat recovery chillers serving existing data halls Source temperature: ~35°C	6 MW available at COP: 4.5 Heat recovery from new data centre chiller
Longer term option 2	Heat offtake from new heat recovery chillers serving existing and new data halls Source temperature: 35°C to 30°C	>6 MW available at COP: 3.9 - 4.5 Heat recovery from new data centre chiller and ducted air from data halls

Based on the findings above, it is identified that the optimum short-term solution is option 1 with heat supply from the existing CHP plant, however a longer-term solution is required for when the CHP plant reaches end of life and is retired. The longer-term solution could be option 1 or 2, depending on the future plans/timelines for the expansion of the data centre and the planned expansion/replacement of cooling equipment.

It is important to note that if the waste heat offtake from the data centre is only available at 13°C (short term option 2), the viability of the heat network scheme would be significantly reduced, unless the data centre is charged for the cooling services provided by the heat network.

Stakeholder engagement with Citibank will be required to ensure that when replacing or installing new rooftop air chillers, that heat recovery chillers are considered as this would provide a long-term high temperature heat source for the Lewisham town centre network.

5 ENERGY CENTRE LOCATION ASSESSMENT

Potential energy centre locations were investigated to identify sites that could accommodate the plant required to supply heat to the Lewisham town centre network. Each potential location was then assessed based on land ownership (prioritising Council-owned land), space available, existing infrastructure, proximity to the heat sources and network connections, and technical viability of connection route.

5.1 Longlist Assessment

Figure 23 and Table 11 summarise the key identified locations.

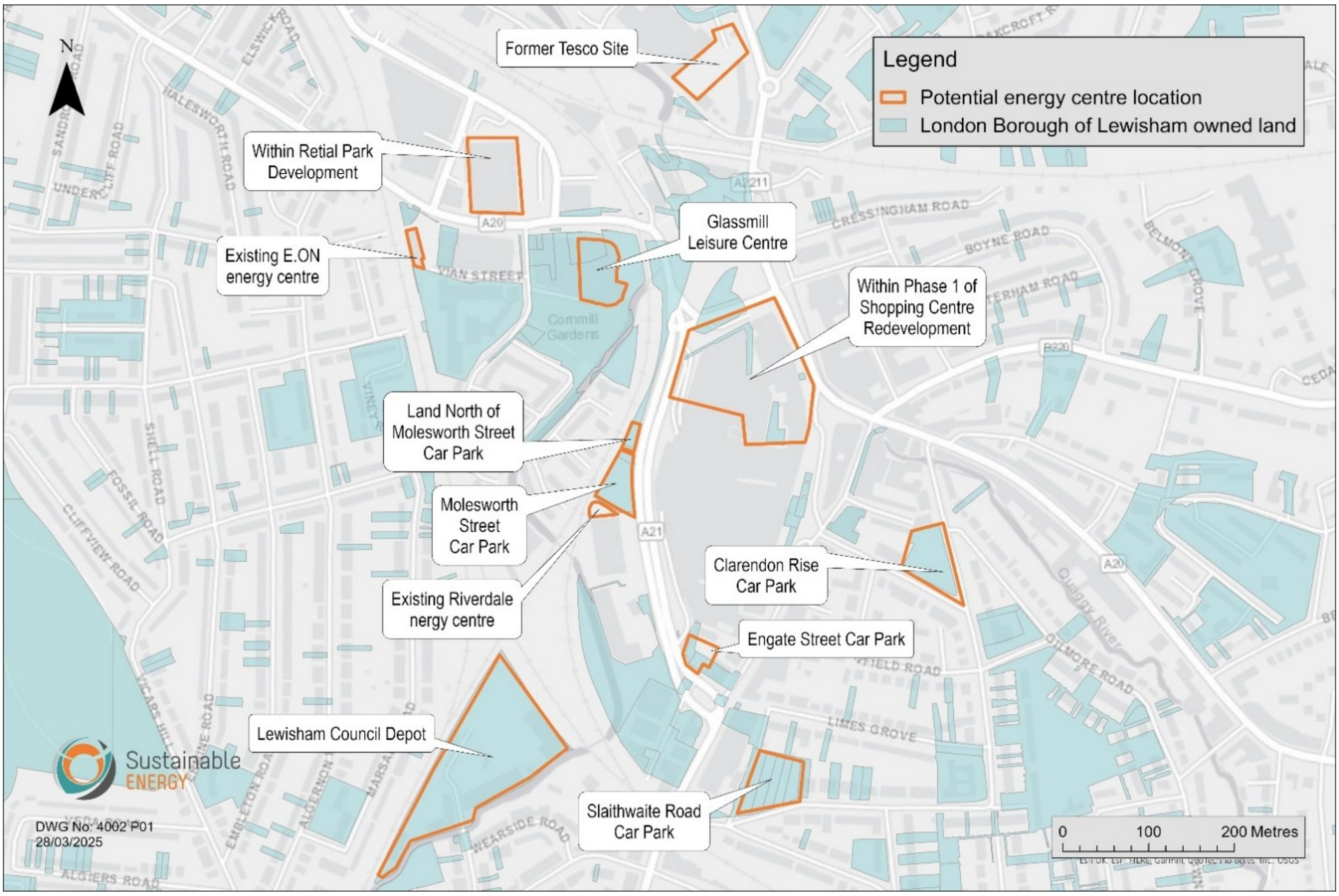


Figure 23: Potential energy centre locations

Table 11: Summary of potential energy centre locations

Site name	Site ownership	Current use	Comments	Shortlisted
Existing E.ON energy centre	E.ON	DNH energy centre	• The existing energy centre has circa 75 m^2 of available space • Limited space restricts the capacity of the heat pump plant that can be installed • Located circa 505 metres from data centre • This is too far away from the data centre heat source and so an alternative heat source would be needed, which would be less economically viable	No

Site name	Site ownership	Current use	Comments	Shortlisted
Retail Park	AMRO (Planned development)	Retail	• The energy centre would need to be constructed within the development • Located circa 450 metres from data centre • Is too far away from the data centre heat source and so an alternative heat source would be needed, which would be less economically viable	No
Former Tesco Site	Private	Retail	• Site allocated for a future planned development • Train tracks run along the west and south sides of the site, requiring the network to pass under a railway bridge, network would require 4 pipes within the road which is not technically viable due to high utility congestion under the bridge • Located circa 650 metres from data centre • This is not close enough to provide a viable connection	No
Glassmill Leisure Centre	LBL	Leisure centre	• Belongs to LBL • No internal plant room space available • Small rooftop area, unlikely to be suitable for heat pump plant • Located circa 340 metres from data centre • Is close enough to provide a viable connection, although this would require 4 pipes within the road which is not technically viable due to space constraints	No
Shopping Centre Redevelopment Phase 1	Planned development	Mixed-use	• Do not wish to host the energy centre on their land • Fairly close to the data centre heat source but not ideally located as an additional road crossing would be required • Due to the phasing of the development the north of the site will be demolished first, while parts of the shopping centre opposite the data centre will remain until phase 3 development and hence to run network to and from the energy centre located within the development the pipework will need to run along A20 and enter the site from north, which will results in longer route and higher costs for traffic management associated with network installation • Depending on the point of connection, could require 80 metres of connecting pipework, or 400 metres if the energy centre is located within phase 1 of the development • Phase 2/3 of the development is close enough to provide a viable data centre connection • Possibility of hosting a containerised temporary energy centre on the development site, capable of meeting the initial heat network demands (until a wider town centre energy centre is developed), which could be further explored by the Council in discussions with Landsec	No

Site name	Site ownership	Current use	Comments	Shortlisted
Molesworth Street Car Park	LBL	Car park	• The proposed location is adjacent to the data centre site, circa 10 metres of pipework required to connect to data centre • Indicated by Transport for London as a preferred temporary bus station during construction of the Bakerloo line extension, but longer term may be available	Yes
Land North of Molesworth Street Car Park	LBL	N/A	• Located circa 60 metres from data centre • This is close enough to provide a viable connection, although this will require routing of buried pipe through Molesworth Street Car Park • Currently land is covered by trees but there are no known TPOs and land is understood to not be protected or ecologically important • Located in flood zone 3b	Yes
Existing Riverdale energy centre	SEEIT	CCHP energy centre	• Adjacent to the data centre building • The town centre energy centre could be built directly above the existing space • Approximately 250 m^2 for the equipment could be available • Limited space for heat pump plant • Will need structural assessment to confirm viability	Yes
Lewisham Council Depot	LBL	Car park	• Currently used for storage of Council vehicles and car park • Ravensbourne River runs along the site boundary • Requires crossing the railway • There is a possible crossing through Lewisham High Street, however, the area is expected to include multiple utilities • Located circa 790 metres from data centre • This is not close enough to provide a viable connection, also this would require 4 pipes within the road which is not technically viable due to space constraints	No
Clarendon Rise Car Park	LBL	Car park	• Located circa 650 metres from data centre • This is not close enough to provide a viable connection	No
Engate Street Car Park	Landsec	Car park	• Located circa 240 metres from data centre • This is close enough to provide a viable connection, but ruled out as land is owned by Landsec and will form part of the shopping centre phase 2 redevelopment	No
Slaithwaite Road Car Park	LBL	Car park	• Located circa 450 metres from data centre • This is not close enough to provide a viable connection	No

5.2 Shortlisted Energy Centre Locations

Molesworth Street Car Park

Molesworth Street Car Park is adjacent to the data centre and would require circa 10 metres of pipework to connect. The site has a footprint of circa 1500 m^2, which would accommodate an energy centre large enough to supply the Lewisham Town Centre heat demands. However, the planned BLE from Elephant and Castle to Lewisham would require TfL to relocate its 18 bus bays (currently located at Thruston Road), during the BLE construction period of circa 8 years. The Molesworth Street Car Park while Council-owned, has a restriction within the title register stating that no disposition is to be registered without the consent of The London Development Agency, TfL and the London Bus Services Limited. Currently, TfL has identified the Molesworth Street Car Park as the preferred location for relocating the bus stands from Thruston Road during the construction of the BLE.

TFL highlighted that any temporary or permanent works to the Transport for London Road Network (TLRN) will require planning approval as well as TfL approval as the Highway Authority. TFL's key priority is to minimise the impact on traffic and potential disruption caused to bus operations during BLE construction and so indicated that the installation of the heat network pipework should ideally be conducted before the BLE works commence.

Land North of Molesworth Street Car Park

The land north of Molesworth Street Car Park, is Council-owned, and currently covered by trees. It has a footprint of approximately 350 m^2 and is located about 60 meters from the data centre. The Council's biodiversity lead is unaware of this land, so it is not expected to have any special designation. However, the Council may have concerns about the loss of trees, vegetation, and permeable surfaces and the impacts this could have on biodiversity, climate adaptation, and flood risk in the area. If this land were to be fully or partially used for an energy centre, the developer would need to ensure that any loss of habitat and drainage is compensated in some other way. The land also sits within a 3b flood zone, which is classified as a functional floodplain, meaning that it is in an area where water would naturally flow or be stored in times of flood with an annual probability of 1 in 20 or greater. Therefore, to develop an energy centre on the land north of Molesworth Street Car Park, a planning application will need to include a Flood Risk Assessment (FRA), a Sequential Test to demonstrate that no alternative sites with lower flood risk are available, and an Exception Test showing that the following criteria are satisfied:

- development that has to be in a flood risk area will provide wider sustainability benefits to the community that outweigh flood risk; and
- the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

Existing Riverdale Energy Centre

Adjacent to the data centre is an existing combined cooling, heat, and power (CCHP) energy centre that provides electricity and cooling services to the Riverdale Data Centre. The CCHP energy centre has a footprint of approximately 250 m^2, and currently houses two CHP engines and cooling towers over two floors,. An additional floor could be added to the structure (subject to a structural assessment to determine viability), or the existing space could be repurposed following the removal of the current CCHP plant, although there are no current plans to decommission the existing plant.

The energy centre plant would be limited to heat pumps only, as there is insufficient space for thermal stores and other heat sources that could increase the network's resilience, such as air heat exchangers.

5.3 Summary

The preferred location for the energy centre is the Molesworth Street Car Park or the land north of Molesworth Street Car Park due to the proximity to the Riverdale Data Centre and the town centre heat loads. However, since securing these preferred locations and aligning them with planned developments may be challenging, all shortlisted options have been included for further assessment.

6 KEY TIMEFRAMES

6.1 Stakeholder Timeframes

Figure 24 shows the key stakeholder milestones and construction timeframes that will need to be considered for the development of the heat network.

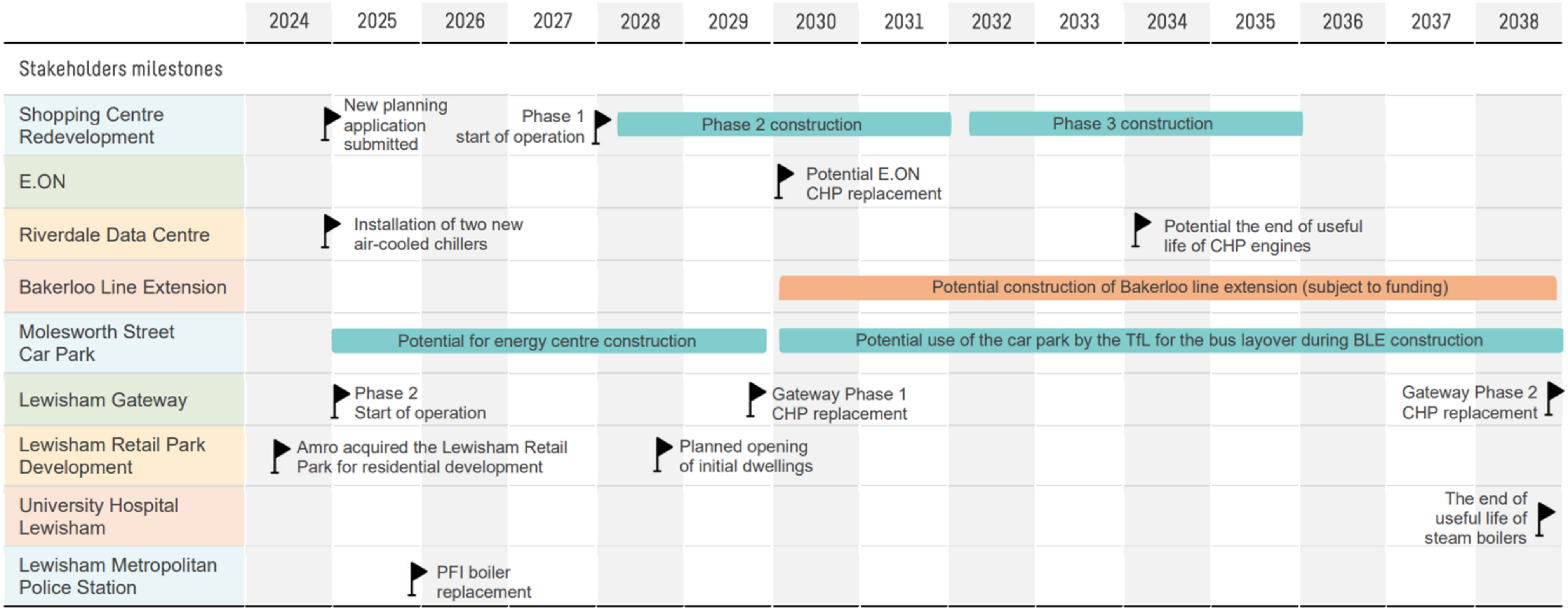


Figure 24: Key stakeholder timeframes

The key risk to developing a network in the Lewisham town centre area is the timing. Key new developments constructed before the town centre heat network is established will be built with individual heat pump solutions and connected to the network once it becomes available. Existing buildings may need to retrofit to low carbon solutions to meet their net zero targets.

6.2 Network Opportunity

The phasing of the Lewisham Town Centre Heat Network has been developed based on stakeholder engagement and key timeframes. 2028 is the critical date by which time the Shopping Centre and Retail Park Developments need to be supplied with heat; otherwise, they will be built with individual heat pump solutions. A town centre network will also be required by 2030 to support the later phases of the shopping centre redevelopment and the connection of Gateway 1, following the possible retiring of existing CHP plant (based on a15 year life).

6.2.1 Network Opportunity by 2028

The Shopping Centre Redevelopment (1,860 residential dwellings and 7,975 m^2 commercial space) and Lewisham Retail Park Development (circa 700 residential dwellings) are expected to be operational by 2028, and require low carbon heat to comply with Part L Building Regulations. Therefore, the initial phases of the Lewisham Town Centre Heat Network should focus on securing connection of these sites. This network opportunity is summarised in Table 12 and Figure 25.

Table 12: Summary of network opportunity by 2028

Opportunity	Metric
Residential connections	2,560 dwellings
Commercial connections	7,975 m^2
Diversified peak demand	2.7 MW
Annual demand	7,989 MWh

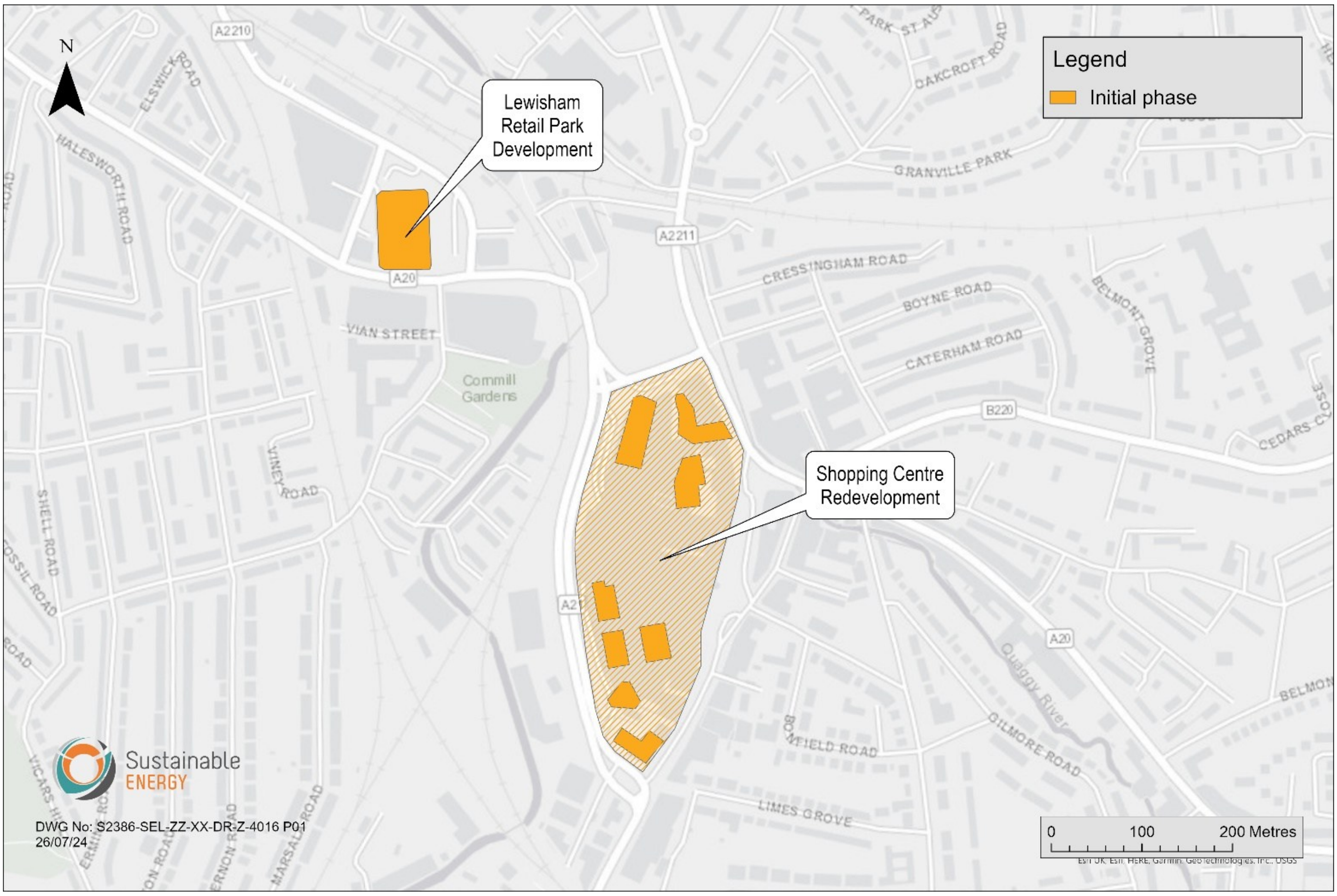


Figure 25: Network opportunity by 2028

Sleeving

The heat produced by heat pump solution could be sleeved to new developments to comply with Part L Building regulations. Sleeving enables existing and new buildings connected to heat networks to be supplied with heat generated by low carbon technology and uses the carbon factor associated with that lower carbon heat source, rather than using an average emissions factor for the entire network. Heat could be sleeved from a heat pump to new developments such as the retail park and Landsec Shopping Centre Redevelopment.

Figure 26: Sleeving principle (Source: Green Heat Network Fund (GHNF) Overview v.8.0)

6.2.2 Network Opportunity Post-2030

The next network phase should align with the planned CHP engine replacements, and the net zero targets of all stakeholders. Later phases of the Lewisham Town Centre Heat Network should focus on providing the opportunity to decarbonise existing networks in the area. The network opportunity is summarised in Table 13 and Figure 27.

Table 13: Summary of network opportunity post-2030

Opportunity	Metric
Residential connections	3,379 residential dwellings from new developments
Commercial connections	3 existing heat networks and 25,201 m^2 new commercial developments
Diversified peak demand	8.0 MW
Annual demand	26,592 MWh

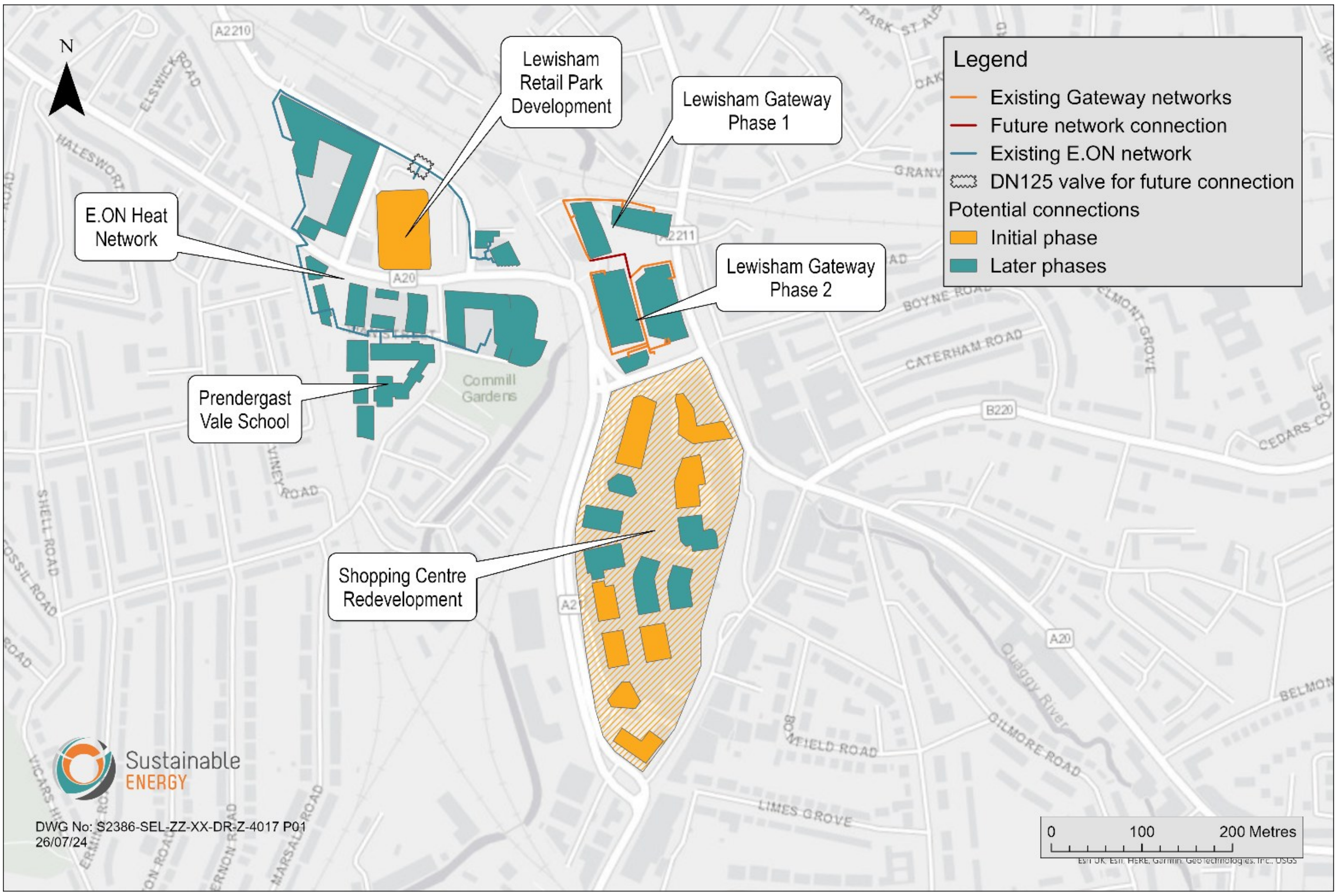


Figure 27: Network opportunity post-2030

6.2.3 Wider Opportunity

Figure 28 illustrates the potential wider opportunity for network connections beyond the Lewisham Town Centre area.

The network could be futureproofed to allow extension to additional heat loads e.g. the University Hospital Lewisham and Lewisham Met Police Station, as well as several other development sites, which could be mandated to connect to the scheme under the future heat network zoning regulations. Figure below shows potential for Tee Off Points.

Once the Molesworth Street Car Park is freed up following delivery of the Bakerloo Line extension, there is potential to build an energy centre with increased space for low carbon capacity.

It is important to note that the wider opportunity will require additional sources of low carbon heat. These could include additional ASHP energy centres and/or increased heat capacity from the Riverdale Data Centre. As well as connection wider cross borough heat networks such as planned Riverside Heat Network utilising waste heat from Cory energy from waste plant or existing Southwark Heat Network utilising waste heat from SELCHP.

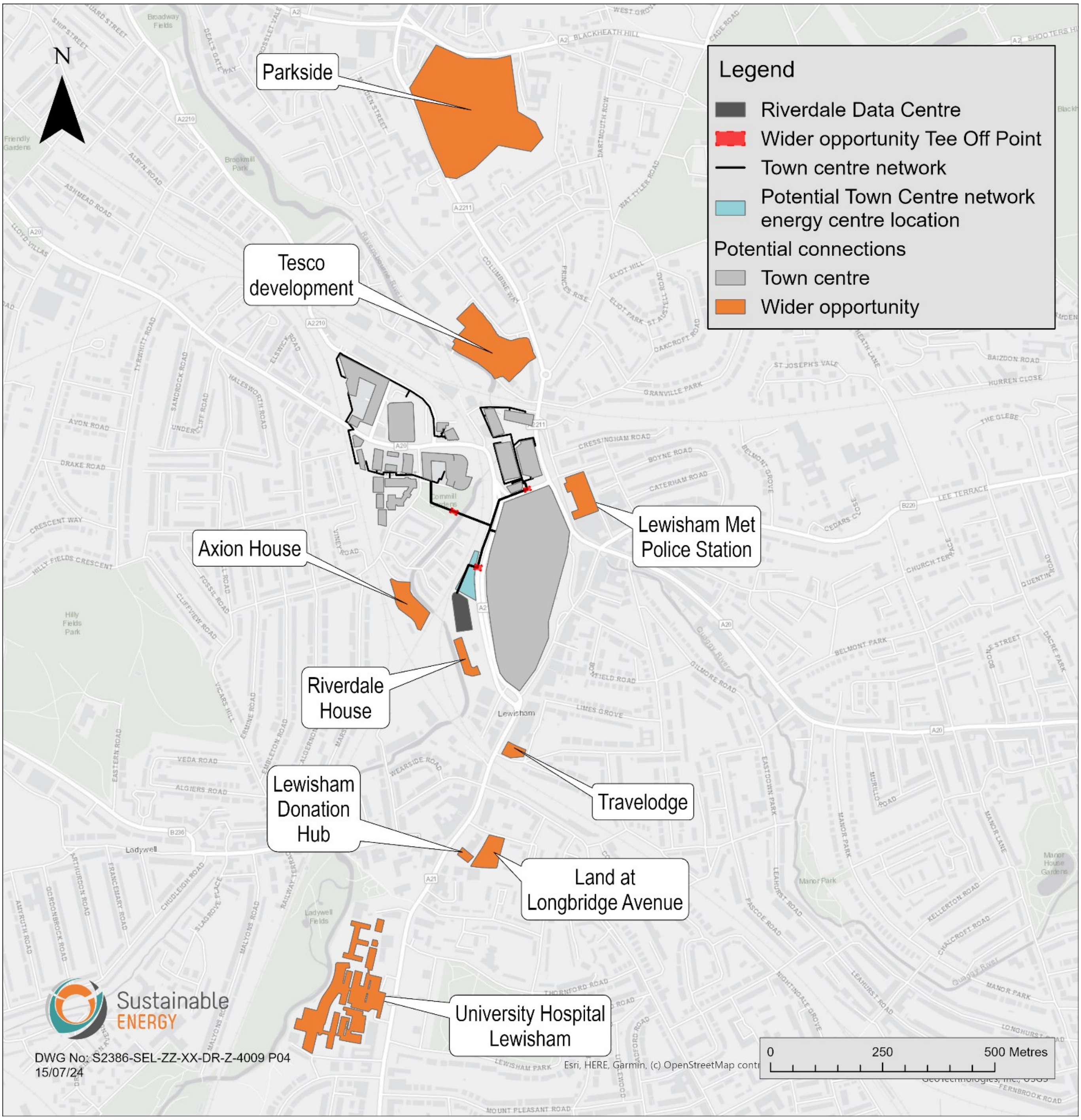


Figure 28: Wider opportunity connections

7 PROPOSED SOLUTIONS

The key constraint to developing a network aligned with stakeholder timeframes and milestones is securing a location for the energy centre. The key options are:

- **Molesworth Street Car Park**: Energy centre utilising waste heat from the data centre, requires negotiations with TfL (buildable land circa 1,500 m²).
- **Land north of Molesworth Street Car Park**: Energy centre on Council-owned land utilising waste heat from the data centre, requires the removal of several trees and further engagement with LBL for planning & biodiversity implications (buildable land circa 400 m² available).
- **Shopping Centre Redevelopment**: Energy centre could potentially be implemented as part of the development or a new dedicated energy centre building on site. This option requires negotiations with the developer.

An alternative or interim/enabling solution could be to install heat pump plant **above the existing data centre CCHP energy centre.** An additional floor could be added, or the space within the existing CCHP energy centre could be repurposed following the removal of the current CHP plant (current building footprint circa 250 m²). The energy centre would utilise waste heat from the data centre, but smaller heat pump capacity would be installed.

Based on the potential energy centre locations, proximity to heat source and priority connections, a number of heat network options have been considered:

- Solution A: Waste heat offtake from the data centre with new energy centre
- Solution B: Waste heat offtake (at reduced capacity) from data centre with energy centre above/integrated with the existing CCHP energy centre

A hybrid approach combining both Solution A and Solution B could also be progressed. This would involve the development of a new energy centre on the land north of Molesworth Street Car Park alongside repurposing or expanding the existing CCHP energy centre. This combined solution would enable a larger overall plant capacity, better aligning with the peak heat demands of the town centre scheme.

7.1 Preferred Solution (A)

The preferred solution is to utilise waste heat from the Riverdale Data Centre and to secure land for an energy centre at either Molesworth Street Car Park, the land north of Molesworth Street Car Park or within the Shopping Centre Redevelopment area. The energy centre will be capable of supplying the key connections identified within Lewisham Town Centre.

Due to the timescales for development of the BLE, and the existing TfL title restrictions, securing of the Molesworth Street Car Park may be difficult. It may also require extensive negotiations to persuade Landsec to accommodate a town wide energy centre within their site, given their current preference for an alternative heat supply. Therefore, the land to the north of Molesworth Street Car Park, which currently has no special designation or plans, could be the most feasible location for the network energy centre. An energy centre on this site would result in the loss of habitat/trees, and would require reinstatement of a suitable drainage system.

The solution would utilise waste heat from the Riverdale Data Centre; the energy centre would connect to the data centre via an ambient pipe running through Molesworth Street Car Park. This connecting pipework which would need to be completed prior to 2030, before TfL progress the planned use of the car park as a bus layover site.

The initial phase of the network will supply heat to the Landsec Shopping Centre Redevelopment and send low carbon heat to the E.ON. heat network, which could then be sleeved to the Retail Park Development. Later phases of the network would include increased heat supply to the E.ON network to provide low carbon heat to the existing E.ON connections and heat supply to Lewisham Gateway 1 & 2 as shown below in Figure 29.

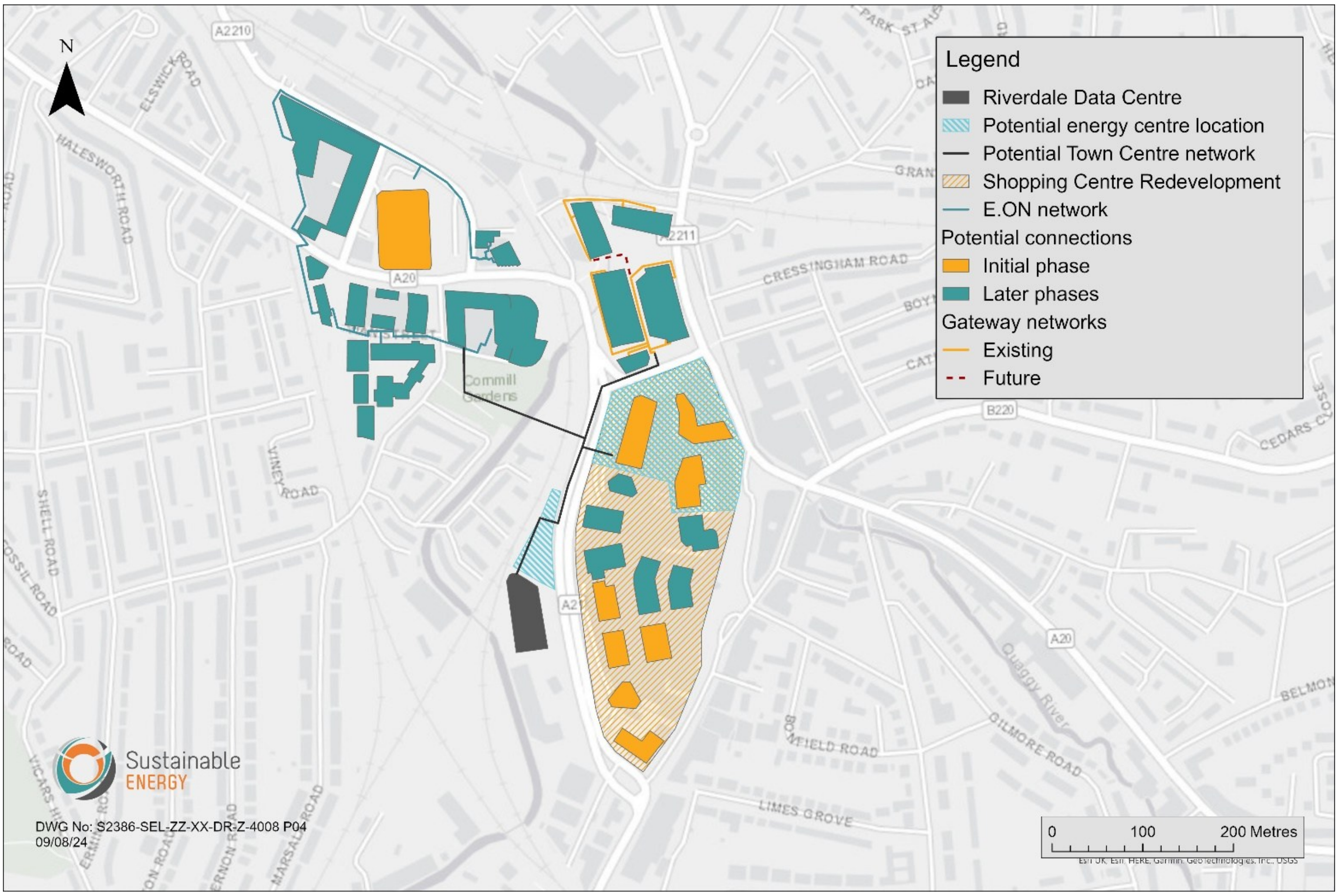


Figure 29: Solution A overview

7.1.1 Energy Centre Concept Design - Solution A

This section summarises the initial scheme concept design for the proposed Lewisham Town Centre Network with an energy centre located on land to the north of Molesworth Street Car Park.

Energy Centre

The proposed energy centre includes modular WSHPs, with waste heat offtake from the data centre as the main heat source. Peak and reserve boilers will be also located within the energy centre and used to provide heat at times of peak demand (if this exceeds the capacity of the heat pumps and thermal stores). A modular heat pump design has been selected to allow individual heat pumps to be taken offline for servicing and maintenance without significantly reducing the capacity of the low carbon heat source. The network controls will prioritise heat from the heat pumps using thermal stores over the boilers.

A summary of proposed energy centre plant capacities is shown in Table 14.

Table 14: Scenario A - Energy centre technology summary

	Initial Phase (Phase 1)	Later Phases (Phase 2)	
		Additional	Cumulative
Heat pump capacity	2 MW	2 MW	4 MW
Peak boiler capacity	2.5 MW of electric boilers	4.5 MW additional electric boilers or utilise E.ONs boilers	7 MW
Thermal store capacity	120,000 litres	-	120,000 litres
Energy centre footprint	348 m^2	-	348 m^2
Air heat exchangers (for redundancy)	2 MW	-	2 MW

Figure 30 shows a process flow diagram (PFD) for the proposed energy centre. Figure 31 and Figure 32 show 3D views of the energy centre. Figure 33, Figure 34 and Figure 35 show the general arrangement of the ground floor, mezzanine floor and the roof respectively.

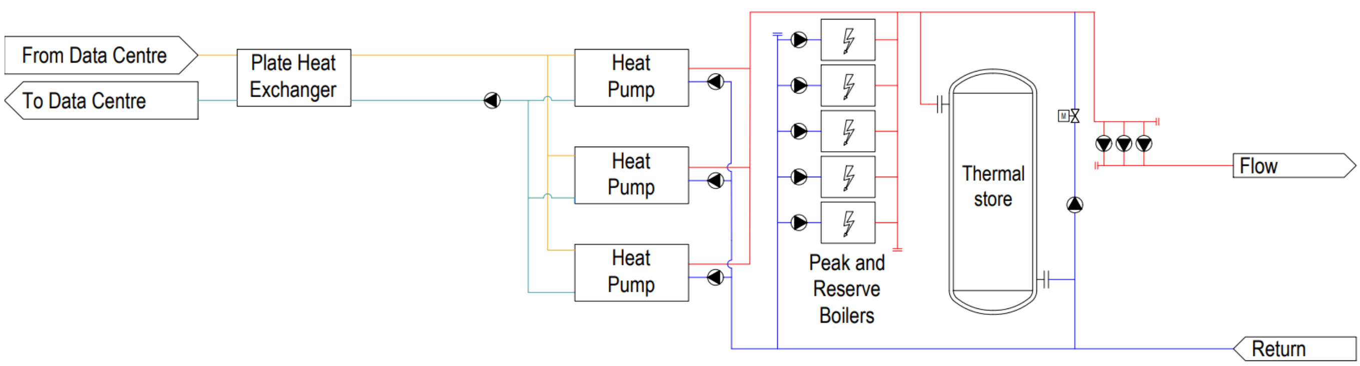


Figure 30: Solution A - Energy centre PFD

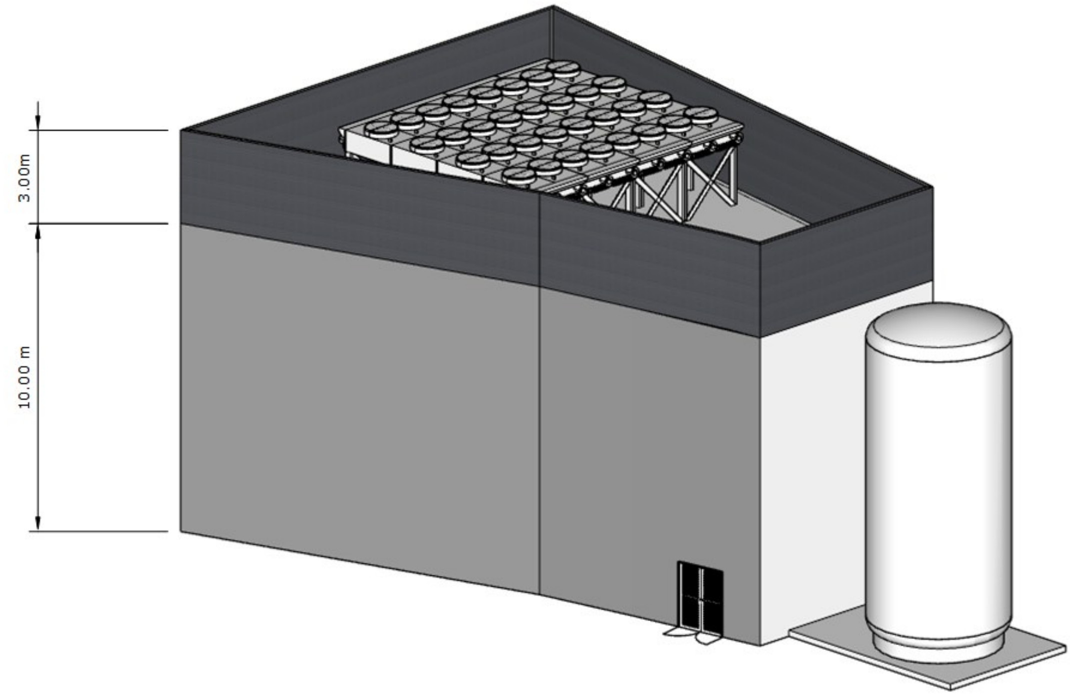


Figure 31: 3D view of the proposed energy centre with air heat exchanger on the roof (Iso view)

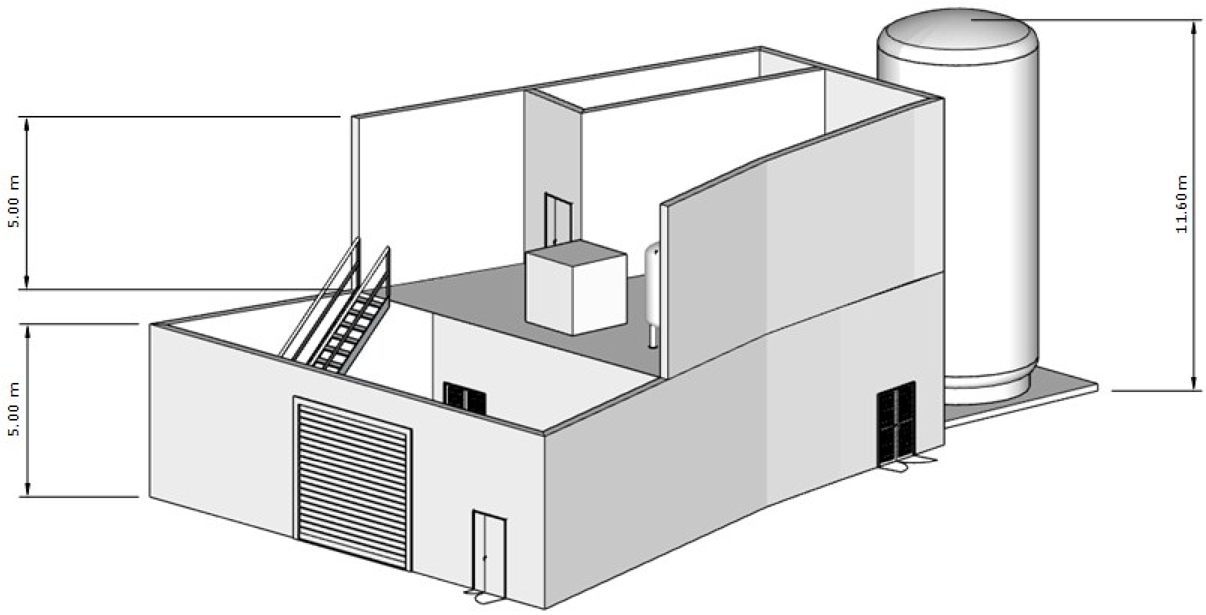


Figure 32: 3D view of the proposed energy centre (Iso inside view)

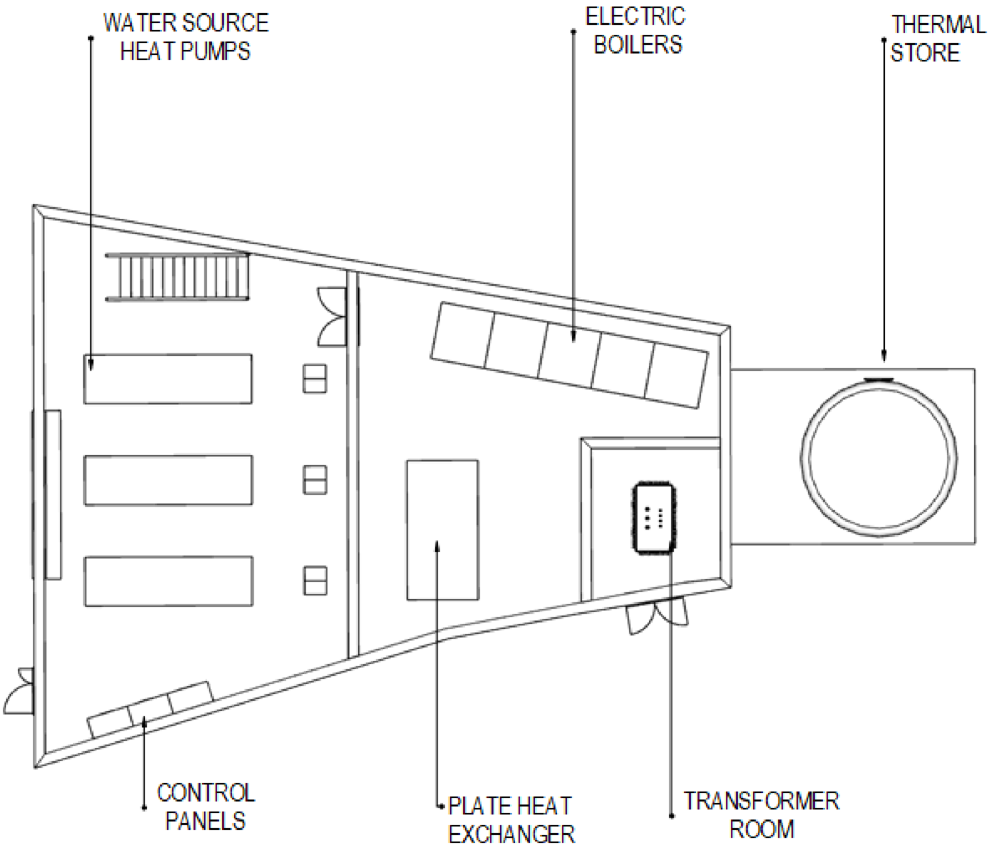


Figure 33: General arrangement drawing of the proposed energy centre – ground floor

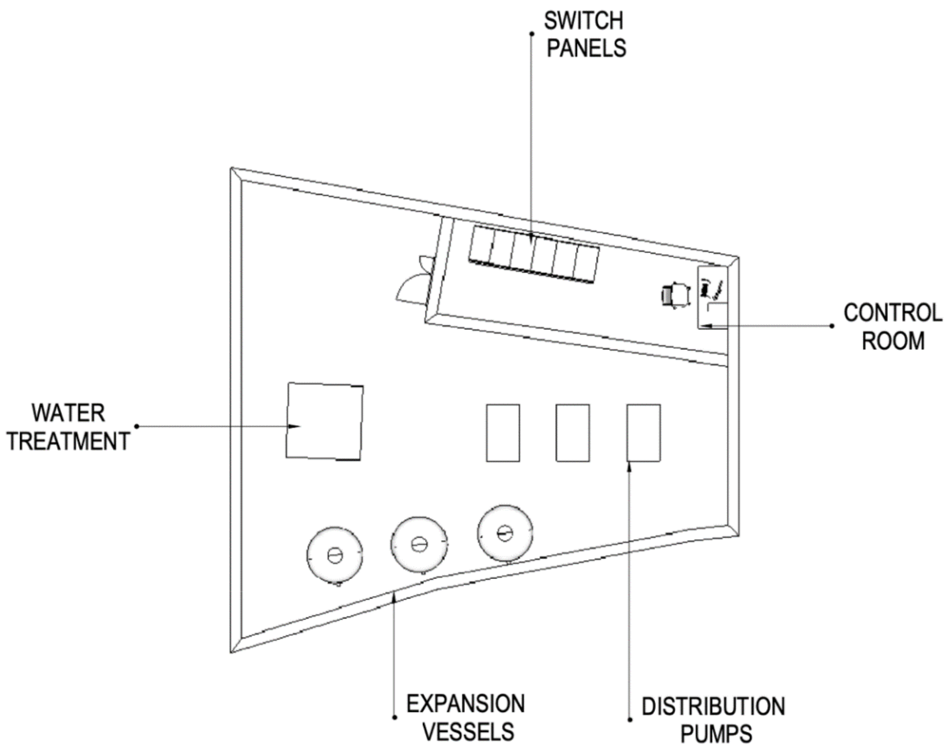


Figure 34: General arrangement drawing of the proposed energy centre – mezzanine floor

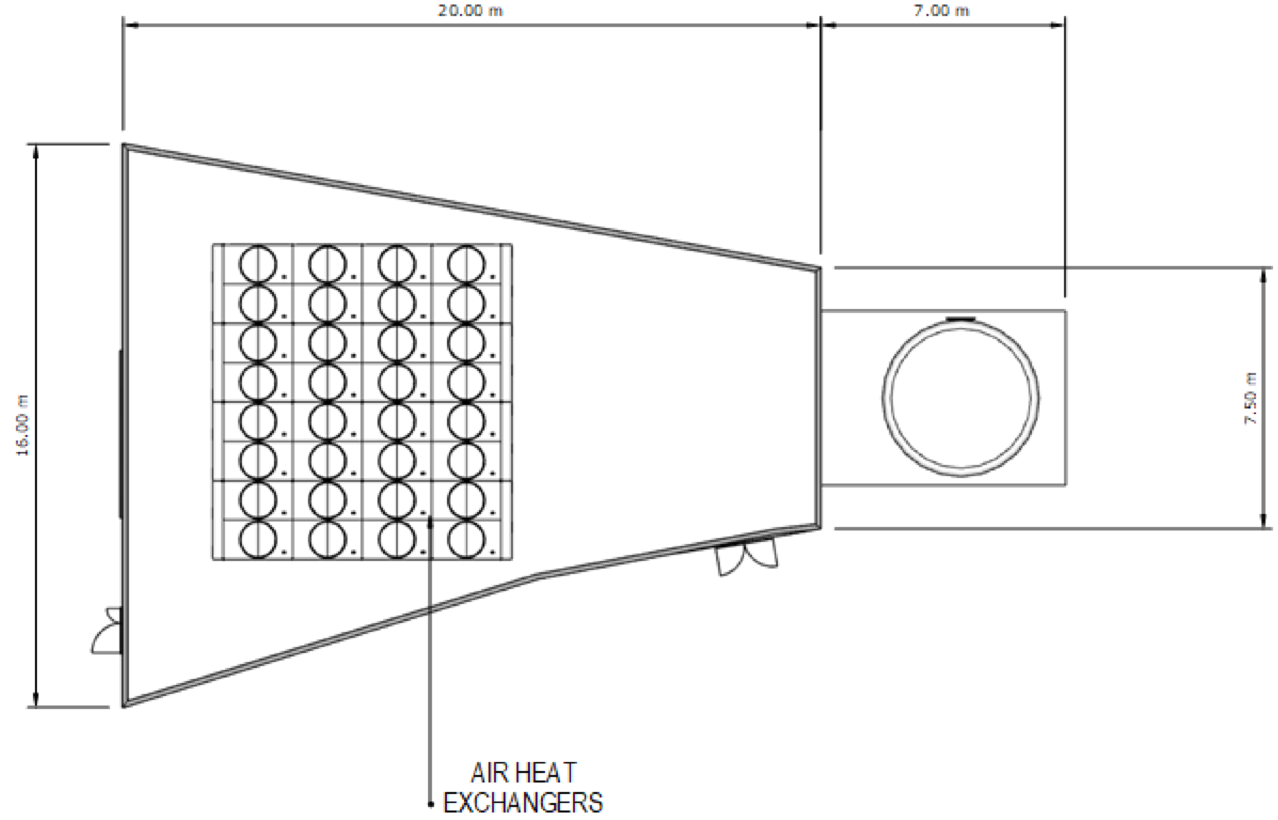


Figure 35: General arrangement drawing of the proposed energy centre – roof

Heat Pump

A detailed sizing exercise has been undertaken to determine the optimum heat pump size, based on the hourly network heat demand profile, network temperatures and the heat source temperature. The modulation limit of the heat pumps and thermal store size was also considered on an hourly basis for a full year. Further details are provided in Appendix 2: Technology Sizing.

Phase 1 includes 2 x 1 MW heat pumps and Phase 2 includes an additional 1 x 2 MW heat pump.

Electrical Connection

An electricity connection will be required at the energy that can supply the heat pumps and back up boilers and ancillary equipment for both the initial and later phase. A budget estimate was requested from UK Power Networks for the electrical connection.

An electrical connection of 7,800 kVa would be sufficient to allow the heat pumps or electric peak and reserve boilers to supply both the initial and later phase of the network (if the heat pumps are offline). A budget estimate of £2,400,000 + VAT was provided, with the Point of Connection at the Deptford Grid Substation. The budget estimate states the works to comprise the transfer of existing feeder to create a spare panel at the 11kV switchboard at Deptford Grid and the establishing of 1 x metered ring main unit (MRMU) substation.

Peak and Reserve Boilers

The preferred option is to install electric peak and reserve boilers rather than rely on peak and reserve heat supply from the E.ON gas boilers due to the potential commercial complexity of heat supply from E.ON.

Therefore, any heat demand not met by the heat pumps and thermal store will be met by electric peak and reserve boilers; this will ensure the lowest possible CO_2e emissions for the network.

Heat generated by electric boilers is considerably more expensive than heat generated by the heat pumps as more electricity is required to generate the same amount of heat, therefore the heat pumps have been sized to supply more than 90% of the heat demand.

Thermal Storage and Control

Thermal storage has been included at the energy centre to maximise the proportion of heat supplied by the heat pumps and reduce the use of the peak and reserve boilers. The thermal storage comprises a large cylindrical, insulated water tank designed to maximise the stratification of the stored volume. The thermal store will be connected in parallel with the heat pumps so that a proportion of low carbon heat is always used to charge the thermal store when it is below full capacity. The Phase 1 energy centre will include 1 x 120 m^3 thermal stores, circa 4.5 m diameter and 11.6 m height.

Metering

All metering should be specified with a suitable accuracy class in accordance with the Measurement Instrumentation Directive, to satisfy the utility requirements for the purchase and sale of heat, water, and electricity for the energy centre. All data recorded by the meters should l be collected by the control system.

- Heat - The energy centre will include ultrasonic heat meters to record the following as a minimum:
    - Heat meters to measure the heat output from each individual heat pump
    - Heat meters to measure the heat output from the electric boilers
    - Heat meter/s to measure the heat export from the energy centre to the network

  The ultrasonic flow sensors measure flow and return temperatures and flow rates and the multi-function meters should calculate the heat energy exported. The heat meters will provide output signals (via MBus) for instantaneous measurements and cumulative measure of flow and energy. Data from all meters should be imported into the control system and used for control and monitoring of system performance.
- Water- The energy centre will include water meters to determine the cumulative use the system pressurisation units, water treatment plant and the overall incoming mains water to the energy centre.
- Electricity – The energy centre will include electricity meters to measure imported electricity from the grid, and individual sub-meters will measure electricity supply to each of the heat pumps to provide performance data.

Variable Speed Pumps

The network distribution pumps will be variable speed pumps in a multi-pump arrangement. The pump set will be speed controlled to maintain a minimum pressure difference at specific locations using index differential pressure sensors within the network. The 3 x pumps will be sized to operate as duty/assist/standby - allowing for modulation in the full range of required supply. The variable speed function allows pump speeds and corresponding electrical consumption of the pumps to be minimised, as peak flow rate conditions will typically only occur for brief periods during a heating season, with average demands being much lower.

7.2 Enabling Solution (B)

Due to the potential challenges of securing land to the north of Molesworth Street Car Park for the Lewisham Town Centre Heat Network energy centre, several enabling solutions have been considered as contingency. These solutions could provide a supply of low carbon heat to the planned developments in time for their start of operation in 2028, which is strategically important for the network's viability. The enabling solutions have been sized to supply 90% or more of the annual heat demand of the planned developments.

Enabling Solution B considers the potential for adding an additional floor to the existing Riverdale Data Centre CCHP energy centre to house a small water source heat pump utilising data centre waste heat. The heat pump would supply heat to Landsec Shopping Centre Redevelopment and send low carbon heat to E.ON. heat network, which could then be sleeved to Retail Park Development.

Further consultation will be required with SDLC to assess the viability of this proposal, as there may be structural constraints to consider.

If Solution B is used to meet the immediate demands of the new developments completing in 2028, a larger energy centre could then be developed on land to the north of Molesworth Street Car Park, or the car park itself if the development aligns with TfL timeframes. This large energy centre could then supply the demands of the wider Town Centre as shown in Figure 36.

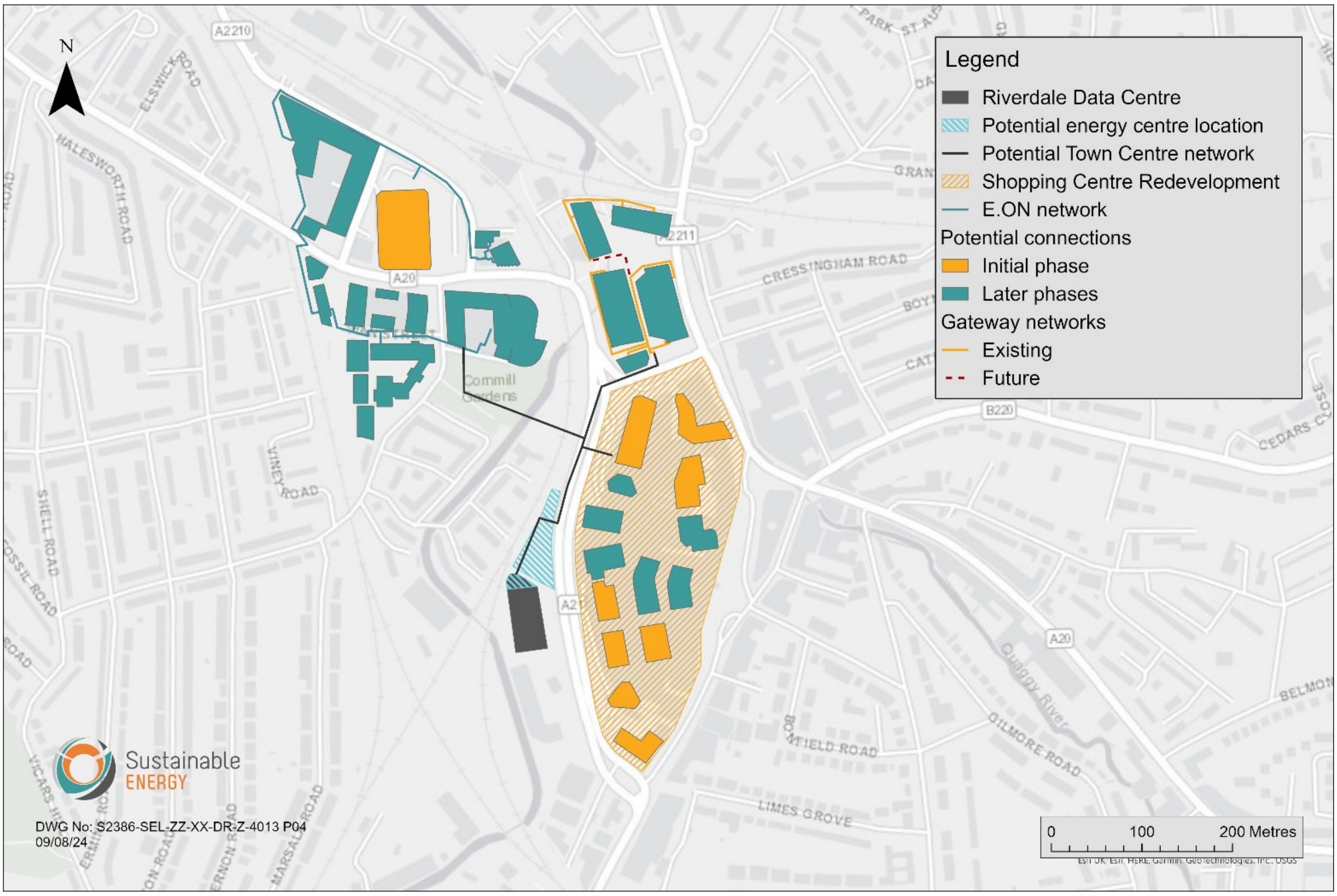


Figure 36: Solution B overview

Technical Viability

Figure 37 shows a high level 3D model of the proposed energy centre for Solution B. The green area represents the existing CCHP energy centre structure (with approximate footprint of 250 m² and height of 11 m) adjacent to the data centre. The proposal is to add an additional floor of approximately 6 metres high, as represented by the grey area (this would require a structural assessment to determine viability). Alternatively, the space within the existing structure could be repurposed following the removal of the CHP plant from the ground floor.

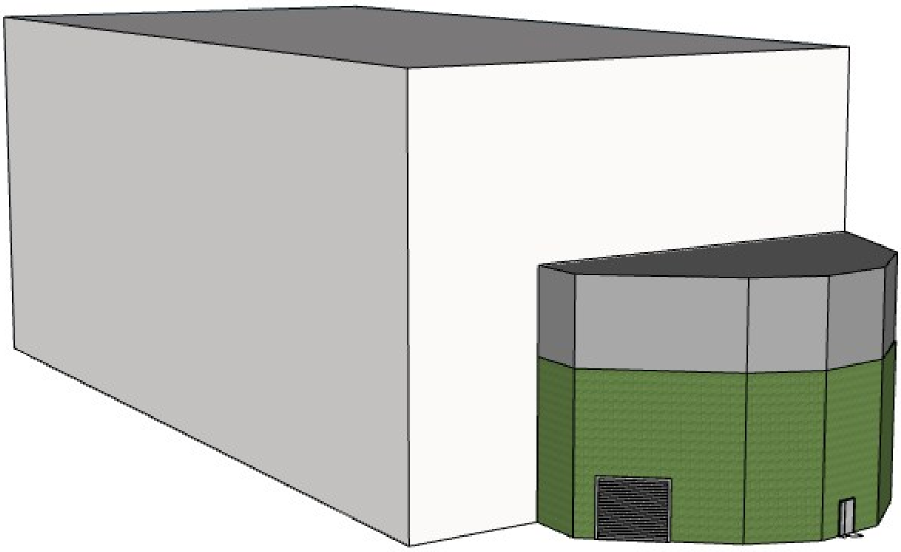


Figure 37: High level 3D model of the proposed energy centre - Solution B

A summary of proposed energy centre plant capacities for Solution B is shown in Table 15.

1.2 MW WSHP utilising data centre heat offtake could supply 92% of the demand required by the Shopping Centre Redevelopment (Landsec Phase 1 & Phase 2) and the Retail Park Development.

The main issue with this solution is the lack of resilience of the heat supply as there would be insufficient space for peak and reserve boilers, back up air source heat pumps or thermal stores. Therefore, peak and reserve boilers and thermal storage would need to be installed separately, either on the land to the north of Molesworth Street Car Park, or within the Lewisham Shopping Centre Redevelopment. Alternatively peak and reserve heat could be supplied by the E.ON energy centre.

Table 15: Scenario B - Energy centre technology summary

	Initial Phase (Phase 1)	Later Phases (Phase 2)	
		Additional	Cumulative
Heat pump capacity	1.2 MW	2.8 MW	4 MW
Electric peak and reserve boiler capacity	2.5 MW	4.5 MW	7 MW
Thermal store capacity	120,000 litres	-	120,000 litres
Energy centre footprint	250 m^2	600 m^2 (TBC)	850 m^2 (TBC)
Air heat exchangers (for redundancy)		2 MW	2 MW

8 NETWORK ASSESSMENT

The key assumptions used for the network route assessment are summarised in the following sections. A detailed utility constraints map for the assessment area is shown in Appendix 3: Network Constraints.

8.1 Network Constraints and Route Assessment

Figure 38 illustrates the key infrastructural constraints around Lewisham Town Centre.

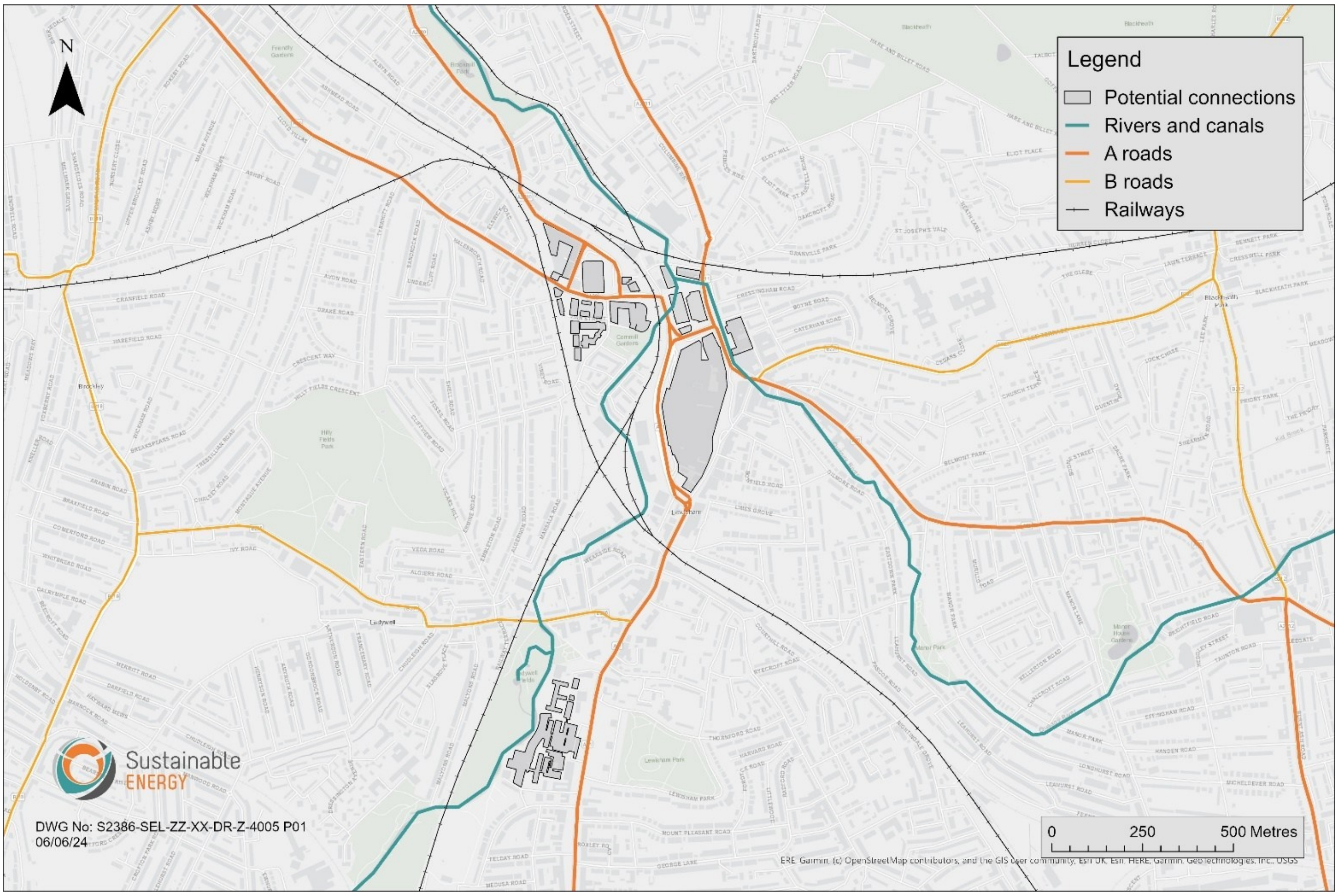


Figure 38: Network constraints

Figure 39 shows the network route and identified pinch points. Table 16 provides further details on each pinch point, along with images from the collected utility data. The network routing considers how the existing E.ON and Gateway heat networks could be directly or indirectly integrated with a Lewisham Town Centre heat network.

The route was identified based on utility data, a site walkover and discussions with the E.ON heat network team, who have knowledge of previous work in the area.

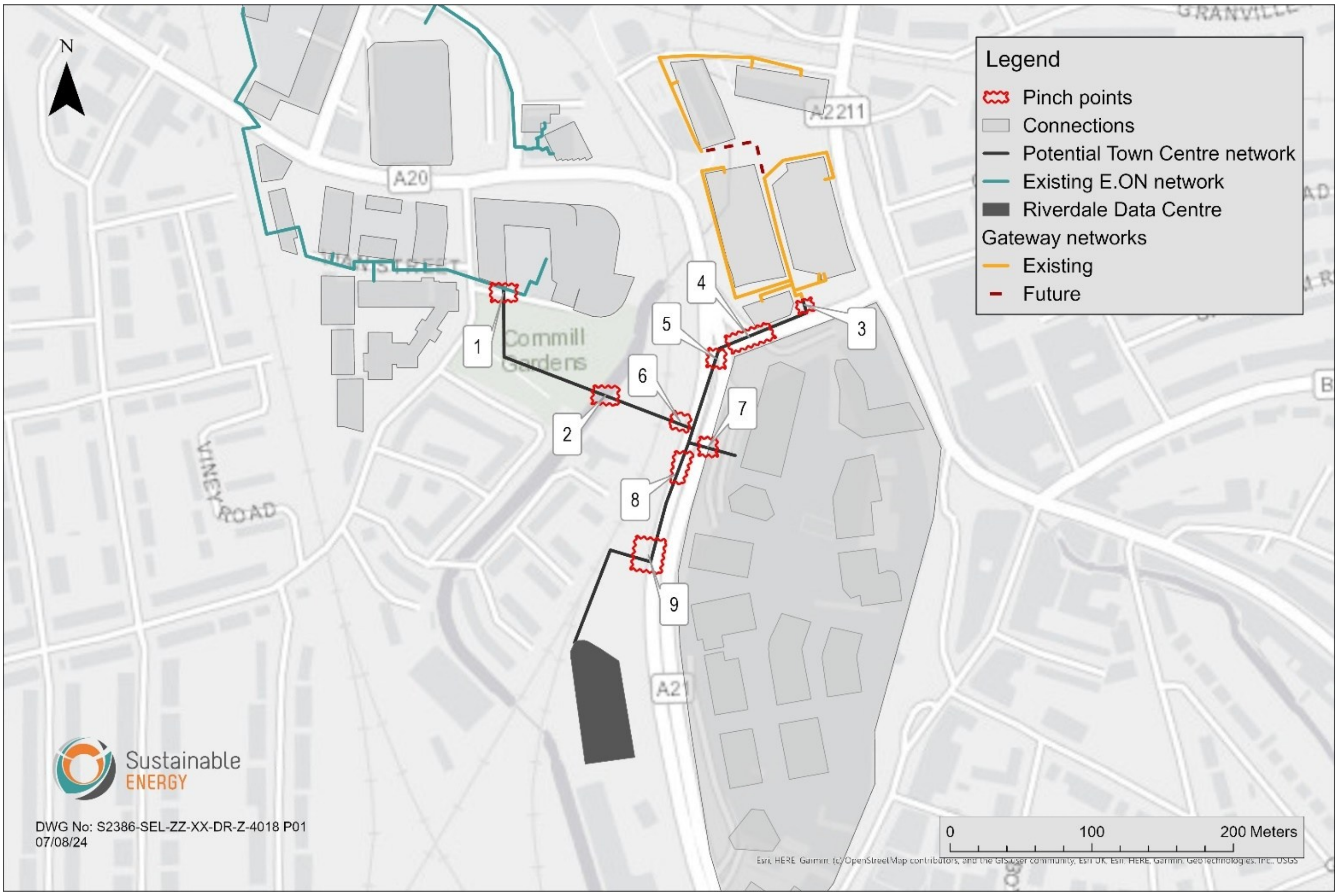
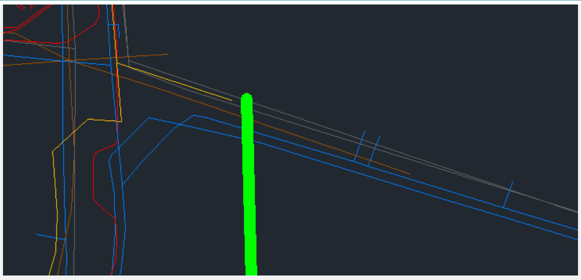
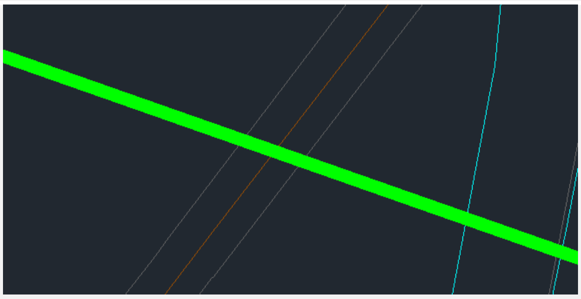
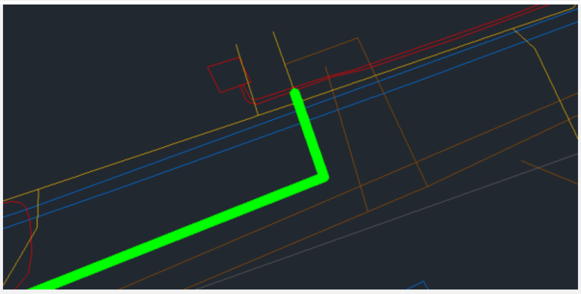
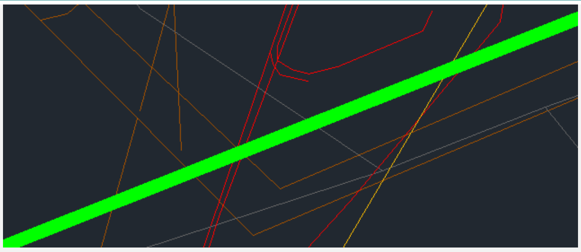
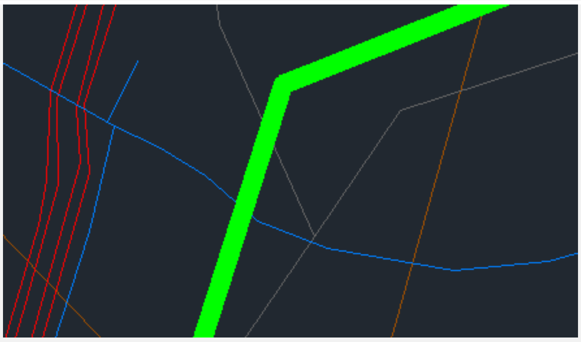
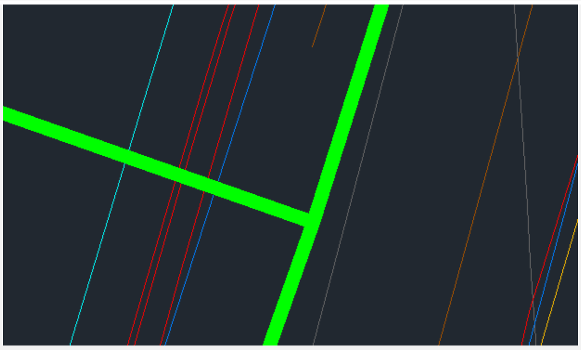
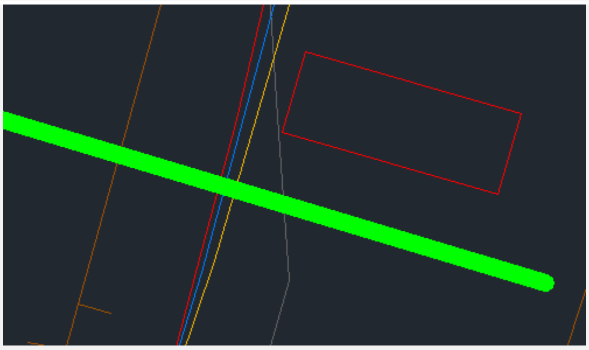
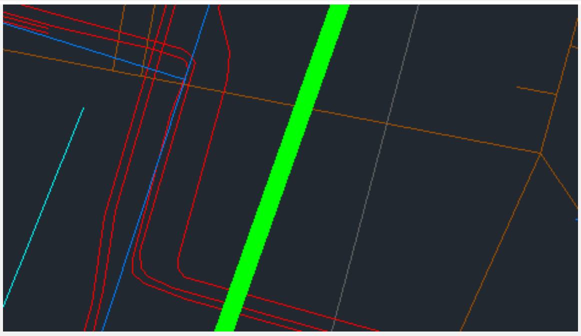
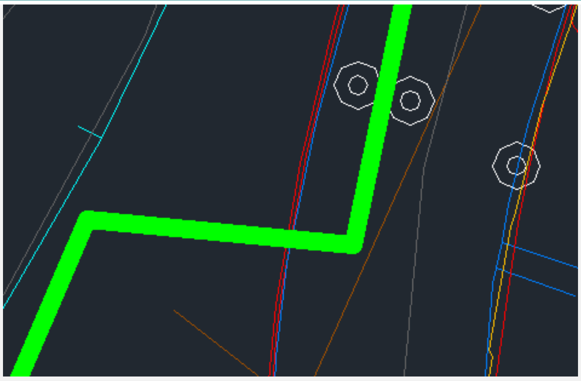


Figure 39: Network route and pinch points

Table 16: Details of pinch points

Map ref	Location name	Pinch points	Image
1	Cornmill Lane	Crosses sewer, water distribution main & water trunk main	
2	Near Cornmill Gardens	Crosses water course	
3	A20 near Lewisham High Street	Crosses low pressure gas main, water distribution main & water trunk main	

Map ref	Location name	Pinch points	Image
4	Molesworth Street	Crosses sewer, low pressure gas main & high voltage (11 kV) cable	
5	Molesworth Street	Crosses water distribution main	
6	Molesworth Street	Crosses high voltage (11 kV) cable & water distribution main	
7	Molesworth Street	Crosses sewer, high voltage (11 kV) cable, water distribution main & low pressure gas main	
8	Molesworth Street	Crosses high voltage (11 kV) cable & sewer	

Map ref	Location name	Pinch points	Image
9	Molesworth Street	Crosses high voltage (11 kV) cable & water distribution mains	

8.2 Network Sizing

Figure 40 illustrates the proposed network route and pipe section sizes.

The network will be future proofed to supply additional key town centre connections and to have the potential to extend to supply wider opportunity connections.

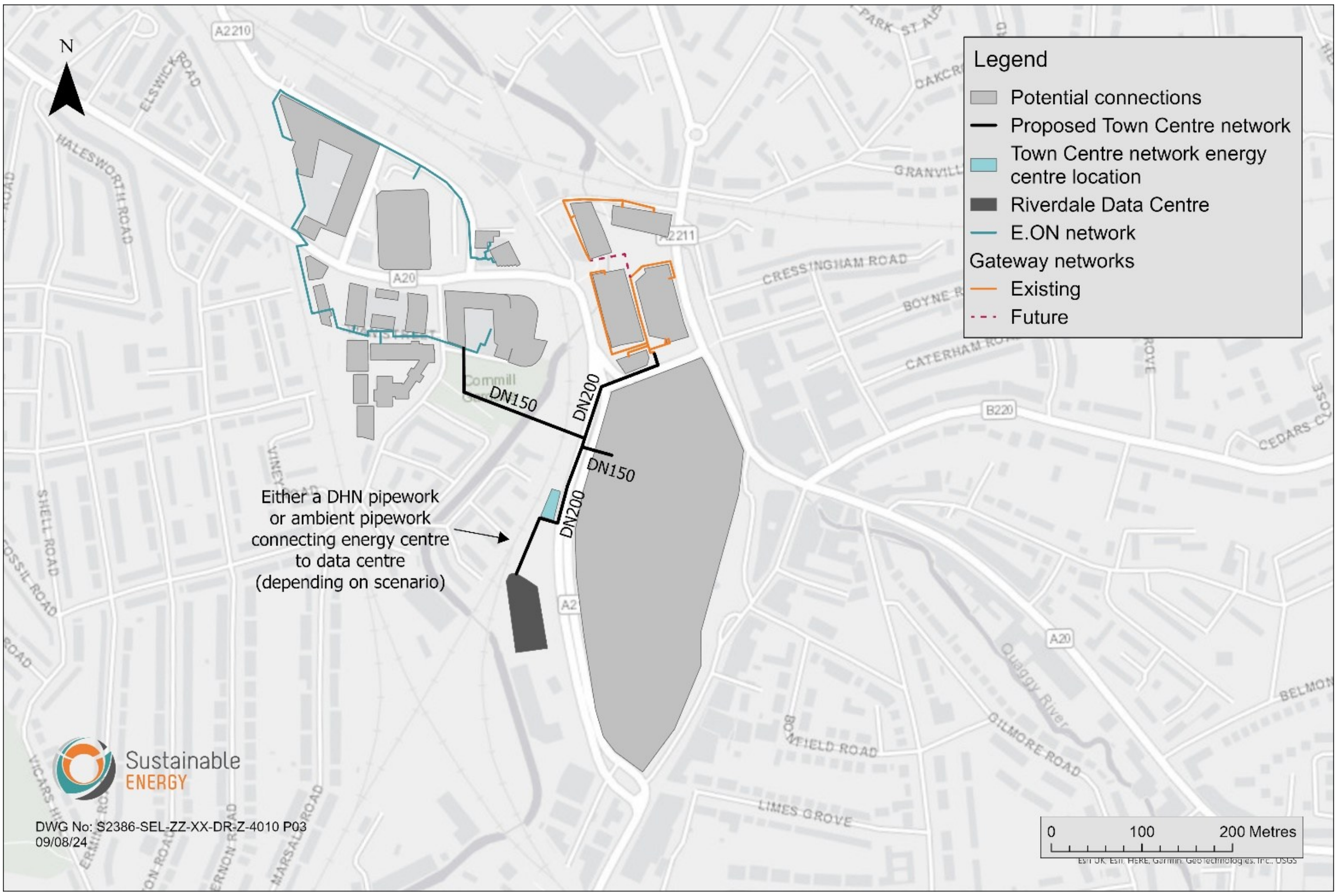


Figure 40: Proposed town centre network

Linear heat density (LHD) is a high-level method of assessing the economic viability of a section of heat network or a specific site connection. To calculate the LHD, the total heat supplied via the pipe section in one year (in MWh) is divided by the length of the network trench (in metres). Based on previous project experience, an LHD of less than 6 MWh/m in London would be considered low potentially making it unviable. The LHD was calculated for the initial and later network phases; Phase 1 has an LHD of 15.0 MWh/m and the total cumulative Phase 2 LHD is 40.3 MWh/m. It is therefore concluded that both phases of the network are likely to be economically viable, due to the high demands present and the relatively short distances between sites.

8.3 Operating Conditions

The proposed operating conditions reflect those required for optimal network efficiency. To ensure heat network losses are kept below 10%[1], the heat network should operate with variable temperature conditions.

Primary Network Temperatures

The primary heat network will provide heat via plate heat exchangers (PHE) to the connecting buildings. This means that the flow temperature on the primary side of each building will need to be slightly higher than required on the secondary side. The network flow temperatures are 75˚C.

The energy centre will contain electric boilers and heat pumps. Electric boilers can operate at higher temperatures without negatively impacting plant efficiency. However the performance of heat pumps will be significantly impacted by the temperature conditions of the network, therefore, to maximise heat pump efficiency, network flow and return temperatures should be kept as low as possible.

Controlled scheduling of heat pumps and peak and reserve boilers will be required to maintain a target overall efficiency for the heat pumps. The heat pumps should not be used to supply higher temperature peak demands; these should be supplied by the peak and reserve boilers. When temperatures and loads are lower (e.g. summer conditions), the heat pump should supply higher levels of demand. Detailed modelling and has been carried out to consider varying heat demand profiles, temperature conditions and carbon impacts to allow sizing of the plant.

The heat distribution systems within planned developments should be designed to minimise secondary side temperatures in accordance with CIBSE / ADE CP1. When connected to a heat network, this will result in lower average return temperatures and therefore an increase in the efficiency of the network and the heat generating technologies.

Secondary System Temperatures

The existing flow and return temperatures of the EON and Gateway networks are higher than would be required by new developments that have been built in compliance with the latest building regulations, and in accordance with CIBSE / ADE CP1. The target secondary side system temperatures for future connections should be 55^{o}C flow and 35^{o}C return.

Operating Pressure

The topography of the assessment area has minimal height variation and no planned high rise buildings. The calculated static pressure required in the network should be circa 3 bar G.

The pumping pressure defines the maximum operating pressure necessary to generate enough head to deliver the required flow rate to all buildings. Hydraulic modelling was carried out to assess how the pressure in the network will vary throughout the seasons and the concept design allows maximum pressure in the system to be maintained at less than 9 bar G.

[1] The CIBSE/ADE HNCoP states that the calculated annual heat loss from the network up to the point of connection to each building when fully built out is typically expected to be less than 10 %

9 TECHNO-ECONOMIC MODELLING

A techno-economic model (TEM) was developed to evaluate the economics of the preferred solution. The key assumptions and parameters for the TEM are shown in Appendix 4: Key Parameters and Assumptions.

9.1 Base Case - Network Summary

As mentioned in section 7.1, the land to the north of Molesworth Street Car Park has been identified as the most viable location for the energy centre.

The base case assumes that the initial Phase 1 of the Lewisham Town Centre Network is supplied by 2 MW WSHPs utilising waste heat from the Riverdale Data Centre and 2.5 MW of electric peak and reserve boilers. The fully built out Lewisham Town Centre Network, as shown in Figure 41, would be supplied via 4 MW WSHPs and 7 MW of electric peak and reserve boilers.

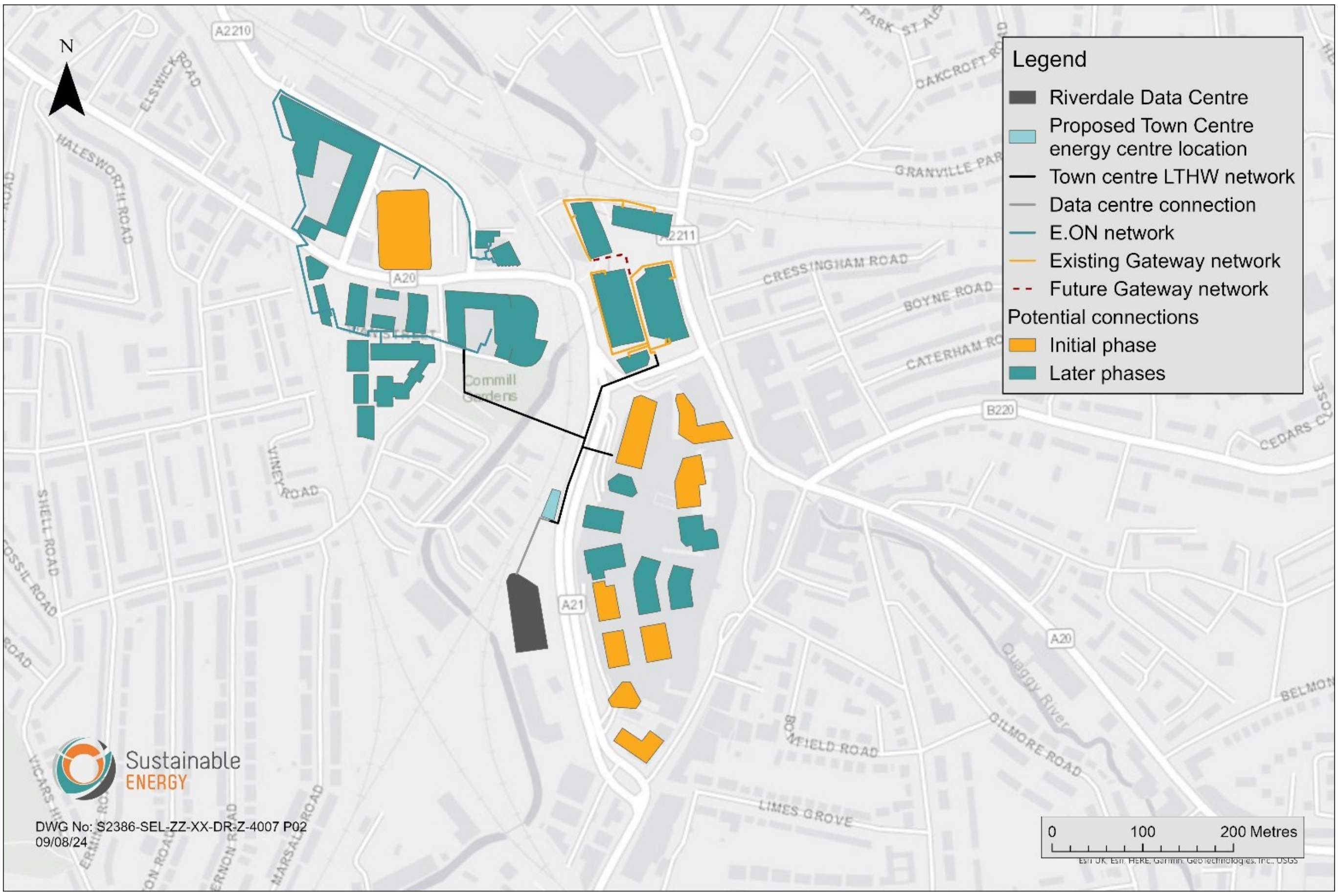


Figure 41: Base case network

A summary of the base case network is shown in Table 17.

Table 17: Lewisham Town Centre Network summary

	Phase 1	Phase 2 (Cumulative)
Total heat demand (excl. network losses), kWh	7,989,268	26,591,738
Network trench length, m	411	551
Network linear heat density, MWh/m	19.4	48.3
Network and building losses, kWh	806,979	2,687,445
Network peak demand (incl. losses), kW	2,777	8,350

	Phase 1	Phase 2 (Cumulative)
Energy centre size, m^2	348	348
Thermal stores, litres	120,000	120,000
WSHP capacity, kW	2,000	4,00
Air heat exchangers (for redundancy), kW	1,000	2,000
Electric peak and reserve boiler capacity, kW	2,500	7,000
Heat demand met by heat pumps, kWh	8,676,042	26,899,732
Heat demand met by peak and reserve boilers, kWh	120,205	2,379,450
% heat demand met by low carbon / renewable technology	99%	92%
Estimated phase start year	2028	2030

9.2 Model Structure

Figure 42 shows an overview of the tabs included in the TEM. Tabs relevant to the standard user are shown in grey. These tabs include the key model inputs and variables and display the key results from the model. Tabs that involve technical inputs and calculations are shown in turquoise. Inputs in these tabs have been input from the SEL technology sizing tool and are set for each phase. A user guide and a full list of assumptions have also been included in the TEM.

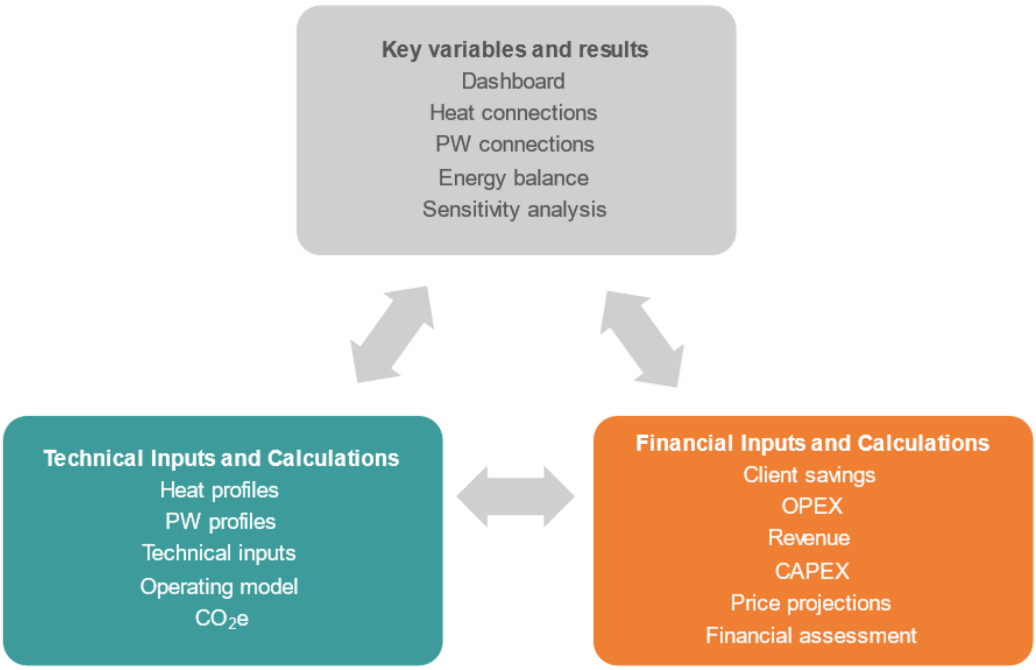


Figure 42: TEM tab structure

9.3 Key Assumptions

9.3.1 Energy Price Projections

To assess the impact of expected future price changes on the financial outputs, the 2023 DESNZ central scenario price projections for natural gas and electricity have been used. The projected changes in the price of electricity and natural gas for residential, commercial and industrial users are illustrated in Figure 43. The projected price variations have been applied to the energy tariffs, which were calculated based on commercial electricity and natural gas price projections.

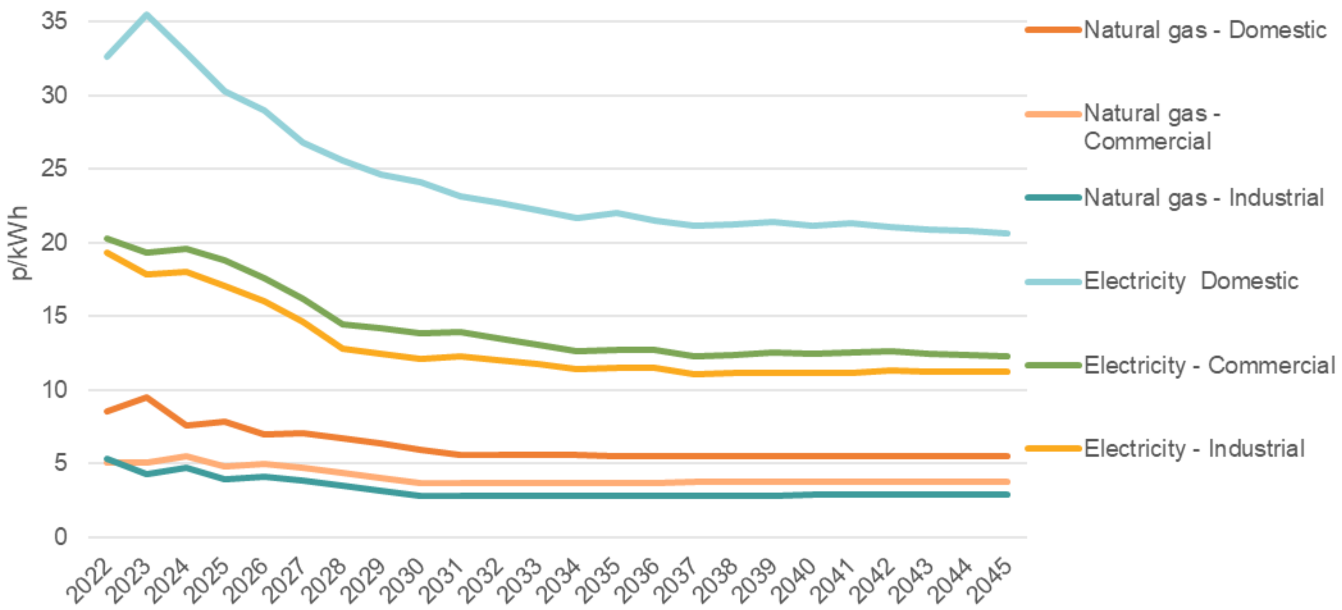


Figure 43: DESNZ[2] price projections - central scenario, updated 2023

The above projections indicate that, in the long term, energy prices will stabilise beyond 2026. The DESNZ low and high scenarios, as well as a fixed indexation rate, have also been assessed for the network option and their effect will be shown as part of the sensitivity analysis. The projected trend may be affected by policy changes over time, such as modifications to the electricity market from market balancing or the Review of the Electricity Market Arrangements (REMA) initiative.

9.3.2 Heat Sales Tariff

The heat sale tariff was developed for the network connections based on the current E.ON commercial/bulk supply tariff. The heat sale tariff comprises two elements - a variable tariff of 9.01 p/kWh and a fixed tariff of £14.64/kW/day. The DESNZ 'central scenario' energy price projections have been applied to the variable heat tariffs over the project lifetime. The variable and fixed tariff elements can be varied in the TEM.

9.3.3 Cooling Sales Value

The cooling produced by the energy centre during heat generation could potentially be sold to the data centre, providing an additional revenue source for the network. The opportunity to sell this cooling depends on:

- the cost of cooling generated by the data centre chillers, and
- the availability of free/waste cooling from the town centre energy centre

The availability of free/waste cooling is dependent on the amount of heat supplied; it is assumed that the cooling created as a byproduct will be sold, and the heat pumps will not be operated solely to provide cooling to the data centre, as this would generate waste heat. The town centre energy centre would offer more cooling energy when there is a higher heat demand for the network during winter peaks.

A standard chiller installed in the data centre could be operating with an energy efficiency ratio (EER) of between circa 5 and 15 depending on the ambient air temperature; a higher EER would result in a lower cost of electricity to generate the cooling required. Based on currently information, it is understood that the data centre is planning to install more air-cooled chillers with free cooling by December 2024. These chillers are expected to have a significantly higher EER during winter than the existing chillers due to a more optimised design and better utilisation of ambient air temperature, as shown in Figure 44. It can be seen that the free cooling chiller could operate with an EER above

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[2] Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal - GOV.UK (www.gov.uk)

50 for much of winter when network heat demand is high, and the energy centre has the most free/waste cooling available to sell.

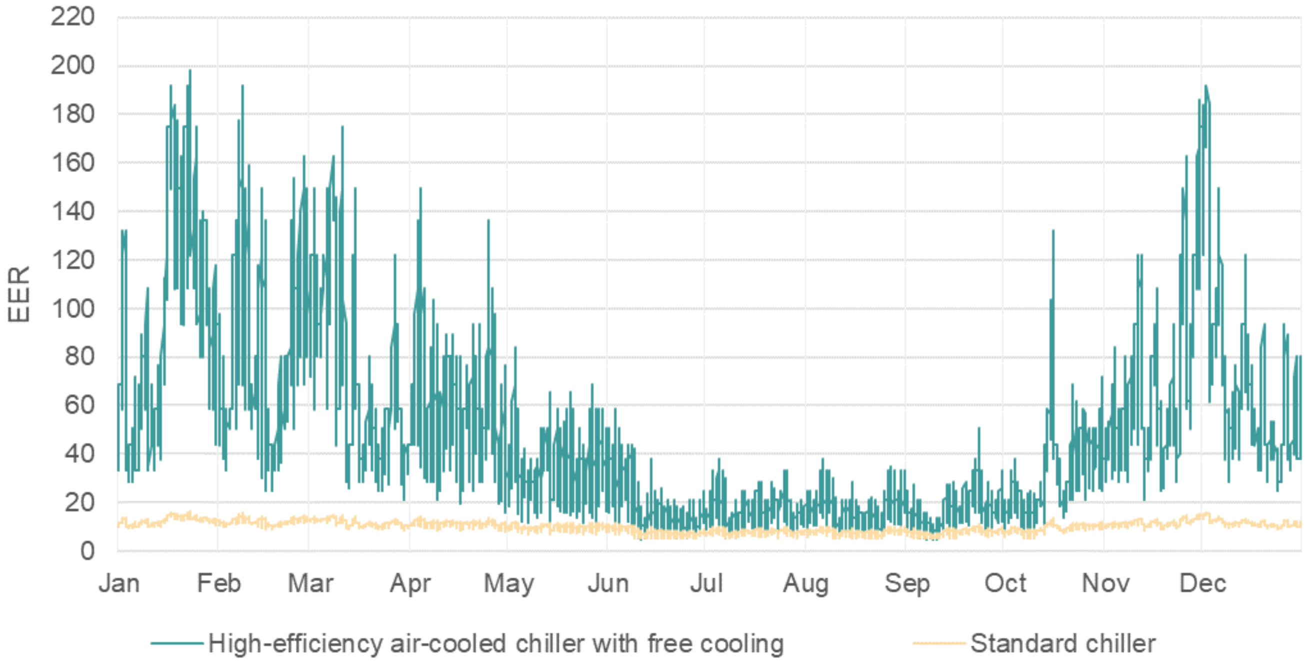

Figure 44: Annual hourly EER of a high-efficiency air-cooled chillers with free cooling and standard chiller

Assuming an electricity tariff of 20 p/kWh for the data centre, the annual hourly cost of cooling generation from the data centre high-efficiency air-cooled chillers was plotted against the network heat demand, as shown in Figure 45. The figure above indicates that when network heat demand is high during winter, and therefore more cooling is available, the value of cooling to the data centre is lowest circa 0.5-1 p/kWh if we look at high efficiency chillers or 1.5-2.5 p/kWh if we consider standard chillers. To sell cooling from heat network energy centre to the data centre, the tariff would need to be lower than existing costs of producing cooling to remain competitive.

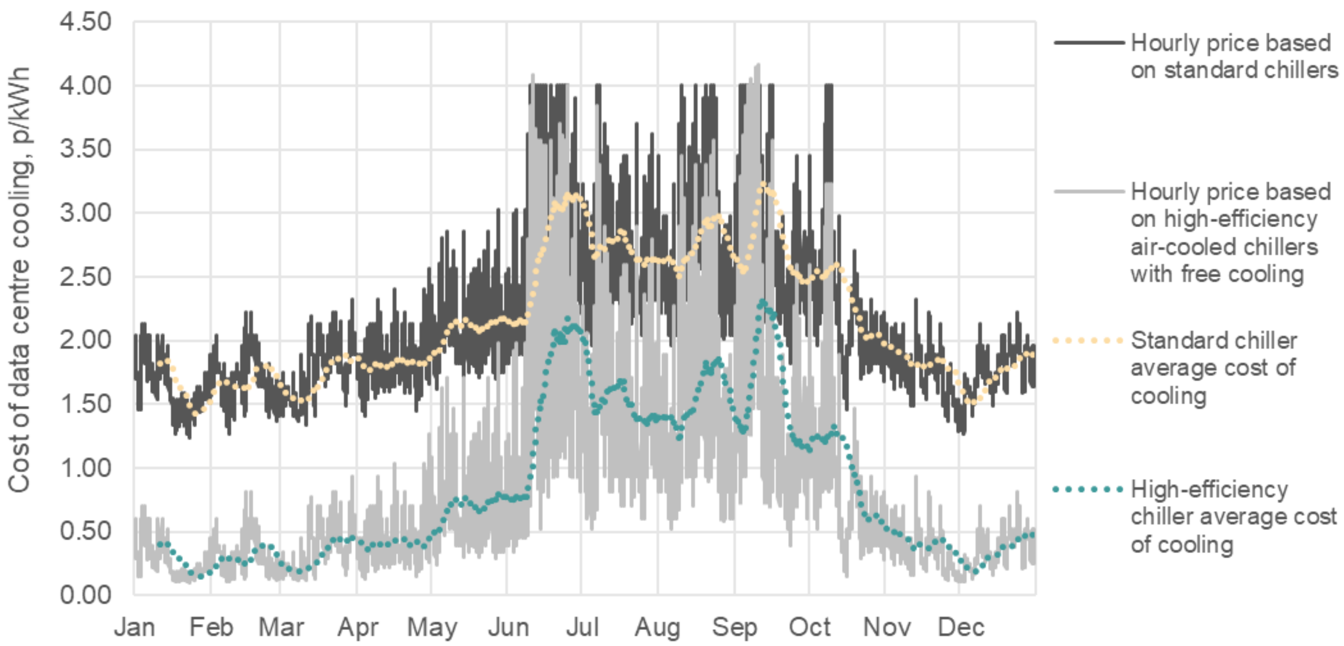

Figure 45: Data centre cost of cooling

Figure 46 shows the cooling available from heat pump generation under the 35°C high temperature data centre waste heat offtake scenario is equal to 15,118,464 kWh of coolth. The effect of coolth sale ON 40 year IRR to data centre has been investigated in section 10.7.

It is important to note that when the cost of cooling is higher for the data centre during summer, the coolth available from the heat network energy centre is at its lowest.

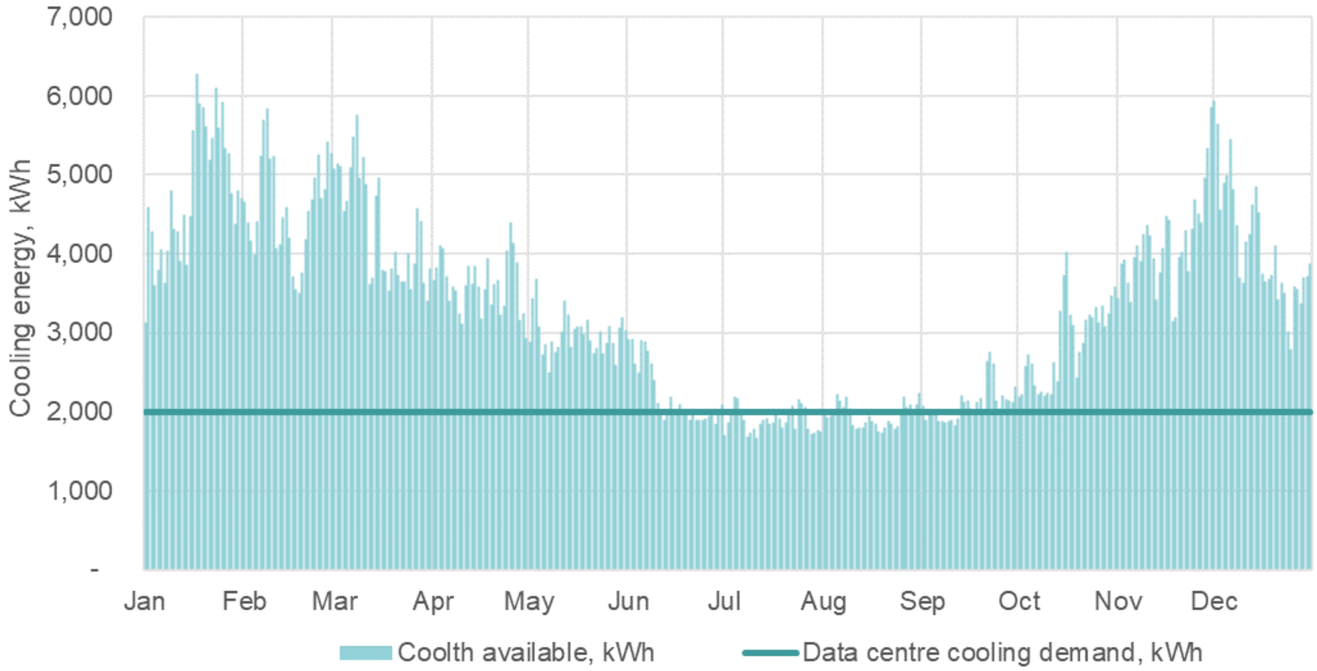

Figure 46: Available coolth from the heat pump energy centre

9.3.4 Energy Centre Tariffs

An electricity tariff of 12.7 p/kWh has been used in the assessment; this was derived from the 2023 DESNZ energy price projections (Figure 43) for commercial electricity cost in the year 2030. These energy price projections were applied to the tariffs to account for variance in energy tariffs over the project lifetime; these figures can be varied in the TEM.

9.3.5 Initial Capital and Replacement Costs

Technology replacement costs are modelled as a sinking fund on an annualised basis and consider the capital costs, expected lifetime, fractional repairs and the length of the business term. Details of expected equipment lifetime are shown in Appendix 4: Key Parameters and Assumptions.

Capital costs for the scheme are based on a combination of previous project experience, quotations for recent similar works, soft market testing and budget quotes.

To develop an accurate estimate of the heat network costs, the proposed network has been broken down into constituent parts (i.e. straight pipe lengths, pipe bends, valves, valve chambers, welds, weld inspections, etc.) for each pipe section. These quantities have then been multiplied by the average rates taken from numerous recent quotations obtained for similar work. A complexity factor has been applied to adjust for areas of lower or higher construction complexity (such as main roads, key intersections and areas of congested utilities). This value was then assessed against the price provided via specific soft market testing.

Estimated capital costs for key plant items (such as heat pumps, thermal storage tanks, boilers, etc.) have been obtained from relevant suppliers. Cost contingency has been applied to each element of capital expenditure as appropriate.

9.4 Economic Assessment

The base case scenario assumes a connection charge of £750/kW is levied on the planned development sites based on their connection capacity. It is also assumed that this charge will apply to existing heat networks that are planned to connect to the town centre scheme, such as the Lewisham Gateway 1 & 2 and the E.ON network. Therefore, a £750/kW connection charge has been assumed for all potential connections.

The 25 year, 30 year and 40 year economic assessments for the fully built out Lewisham Town Centre Network are shown in Table 18. CAPEX and key assumptions can be found in 'Appendix 4: Key Parameters and Assumptions'.

Table 18: Economic assessment results

Economic Indicators		Fully built out network
Total capital costs (including contingency)		£15,668,166
Total connection charge		£8,227,500
25 years	IRR	8.1%
	NPV	£4,871,370
	Simple payback	11 years
	Net income	£11,953,720
30 years	IRR	8.5%
	NPV	£6,199,076
	Simple payback	11 years
	Net income	£15,695,218
40 years	IRR	8.7%
	NPV	£8,170,397
	Simple payback	12 years
	Net income	£23,041,347

The capital costs, operational expenditure, revenue and cumulative cash flow for the full network are shown in Figure 47.

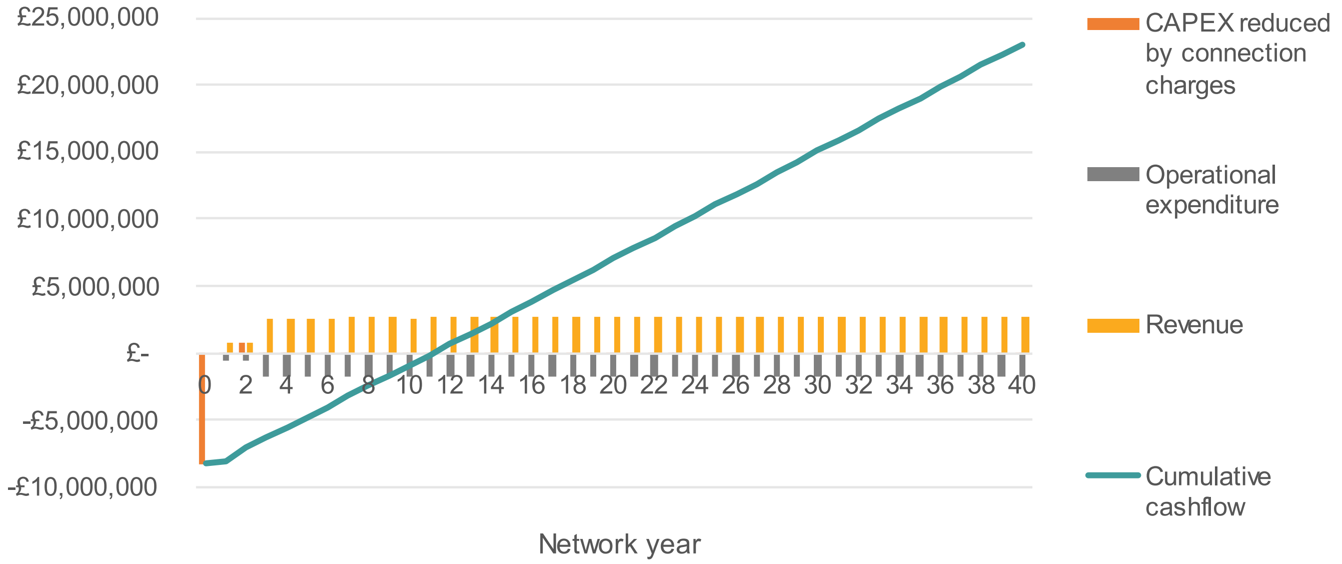

Figure 47: Network cumulative cash flow - 40 years

9.4.1 Green Heat Network Fund

DESNZ provides capital support for the development of heat networks as they are seen as a key part of delivering the UK's legally binding commitment to achieve net zero by 2050. Capital support is currently provided via the Green Heat Network Fund (GHNF) which was launched in April 2022. The GHNF is a £288m fund available to support heat network projects with capital grants of <50% of the project CAPEX. Key metrics must be met by the network to make it eligible to apply to the GHNF.

Table 19 summarises the performance of the full heat network against these eligibility criteria. It is important to note that the last round of GHNF funding is scheduled for early 2025 and is expected to be highly competitive. Other potential funding opportunities are described in section 13.3.

Table 19: Network performance against Green Heat Network Fund eligibility criteria

Metric	Minimum eligibility requirement	Performance of proposed network
Carbon gate	100 gCO_2e/kWh thermal energy delivered	The carbon intensity of the network is 53 gCO_2e/kWh for year 1
Customer detriment	Domestic and micro-businesses must not be offered a price of heat greater than a low carbon counterfactual for new buildings and a gas/oil counterfactual for existing buildings	Heat sales tariffs have been calculated based on the commercial heat tariffs charged by E.ON, representing the existing heating tariffs in the area
Social IRR	Projects must demonstrate a social IRR of 3.5% or greater over a 40-year period	The 40-year social IRR is circa 23.4% for the Phase 2 network
Minimum demand	For urban networks, a minimum end customer demand of 2 GWh/year is required. For rural networks, a minimum number of 100 dwellings connected is required	End customer demand is 8 GWh/year for the Phase 1 network
Maximum CAPEX	Grant award requested up to but not including 50% of the combined total CAPEX +	The maximum grant funding available according to this metric is £7,834,083 (for full network)

Metric	Minimum eligibility requirement	Performance of proposed network
	commercialisation costs (with an upper limit of £1 million for commercialisation)	
Capped award	The total 15-year kWh of heat/cooling forecast to be delivered will not exceed 4.5 pence of grant per kWh delivered (subject to review by GHNF)	In the last round of GHNF (early 2025) projects with a funding level below 2.5 p/kWh are more likely to receive grant funding according to the HNDU. A funding cap of 2.5p/kWh would result in a maximum grant of £ 9,041,778 although this equates to 60% of CAPEX and the maximum grant allowable is <50%
Non-heat/cooling cost inclusion	For projects including wider energy infrastructure in their application, the value of income generated/costs saved/wider subsidy obtained should be greater than or equal to the costs included.	No non-heat/cooling infrastructure is included in the base case

Based on previous project experience, a grant of circa 35% is more likely to be acceptable to funders than a higher grant level. A grant of 35% would equate to £5,358,056and circa 1.5p/kWh for the total heat delivered over 15 years.

9.4.2 Effect of Grant Funding

Table 20 shows the impact of grant funding on project economics. This assumes 35% grant funding is secured. It is assumed that the grant funding secured will be spent in year 0 of the network.

Table 20: Economic assessment with grant funding

		Fully built out network
Total capital costs (including contingency)		£15,668,166
Total connection charge		£8,227,500
Total grant funding		£5,358,056
25 years	IRR	24.8%
	NPV	£10,229,426
	Simple payback	5 years
	Net income	£17,311,776
30 years	IRR	24.4%
	NPV	£11,557,133
	Simple payback	5 years
	Net income	£21,053,275
40 years	IRR	23.9%
	NPV	£13,528,454
	Simple payback	5 years
	Net income	£28,399,404

The capital costs, operational expenditure, revenue, and cumulative cash flow for the fully built out network with £5.5 million of grant funding applied are shown in Figure 48.

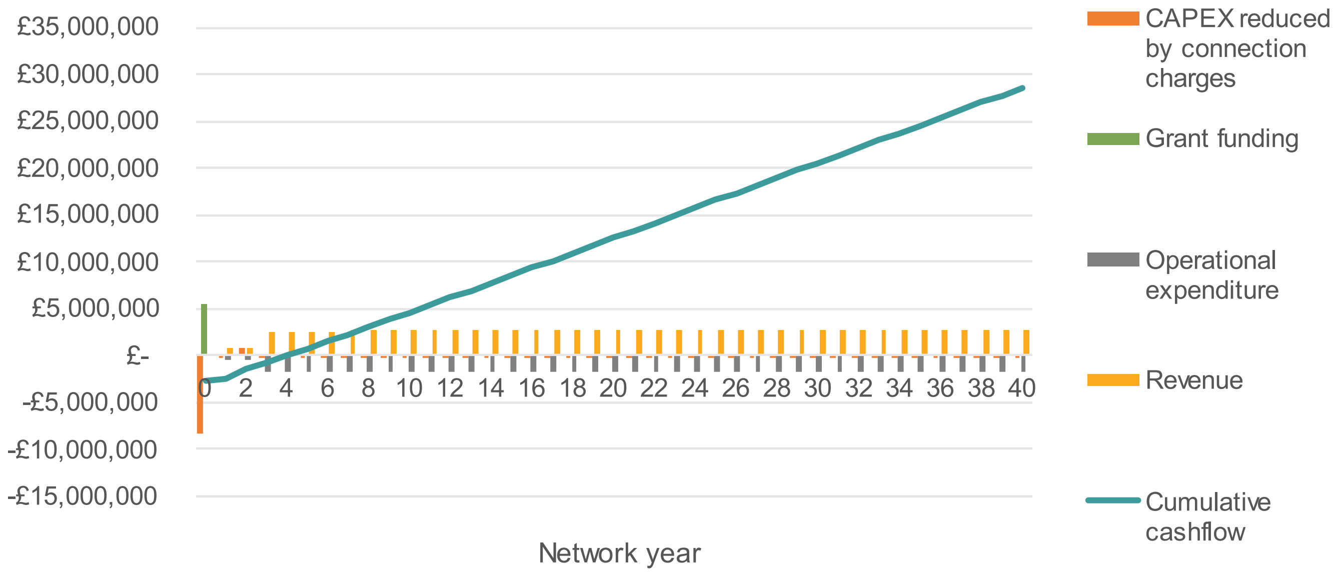

Figure 48: Lewisham Town Centre Network cumulative cash flow with GHNF - 40 years

10 SENSITIVITY ANALYSIS

A sensitivity analysis was undertaken for the Lewisham Town Centre Network preferred solution (A) based on the key network risk, parameters and variables. The same sensitivity analysis was also undertaken for Solution B (smaller heat offtake from data centre with plant located above/integrated with the existing CCHP energy centre), for direct comparison of the contingency solution against the preferred solution.

Key risks for the network include:

- Capital cost
- Energy tariffs including: heat sales tariffs, energy centre electricity purchase tariffs and data centre waste heat purchase costs
- Heat pump SPF

1.1 Interpreting the Sensitivity Graphs

In the majority of the graphs presented below, the x-axis represents the percentage variation of the parameter being varied. The 0% variation is therefore the base case and is typically in either the centre of the graph or at either end.

From the base case, the parameter is varied by a fixed percentage (usually -30%, -15%, +15% and +30%), and the impact on the project IRR is presented.

If a graph displays a horizontal line, this will indicate that the parameter being varied does not affect the project. A very steep line on the other hand indicates that the project is very sensitive to small changes in the parameter being varied, indicating a high risk.

10.1 Enabling Solution (B)

A comparison of the economic performance of contingent network solution (B) over a 40 year project period, against the preferred solution (A) is shown in Table 21.This illustrates that solution A has the largest 40-year IRR. The economics assume that the enabling solution is implemented for Phase 1 and the main energy centre (Molesworth Street car park/adjacent land) is implemented in Phase 2.

Table 21: 40-year full network economic performance of Solution A and Solution B

		Solution A (base case)	Solution B
Total capital costs (including contingency)		£15,668,166	£16,685,640
40 years	IRR	8.7%	8.2%
	NPV	£8,170,397	£7,284,969
	Simple payback	12 years	13 years
	Net income	£23,041,347	£21,801,391
	CO_2e intensity average of heat delivered	10	10
First year CO_2e intensity of delivered heat		53	60

10.2 Reduced Source Temperature

Waste heat is produced by the data centre CCHP plant at 35°C. The base case assumes that the CCHP waste heat will connect to the heat network in Phase 2, improving system efficiency. However, if the connection to the CCHP is no longer viable, it has been assumed that waste heat would be recovered from the data centre cooling circuits. This would lead to a reduction in the waste heat temperature from 35°C from the CCHP plant to 13°C from the data halls, which would result in a reduced heat pump COP (from 3.87 to 2.48). The 40 year network economic performance of all solutions are shown in Table 22.

Table 22: Effect of reduced waste heat temperature on the 40-year full network economic performance

		Solution A (base case)	Solution B
Total capital costs (including contingency)		£15,668,166	£16,685,640
40 years	IRR	1.4%	0.6%
	NPV	-£2,370,993	-£3,256,421
	Simple payback	31 years	36 years
	Net income	£2,349,433	£1,109,477

10.3 CAPEX

The estimated cost for the energy centre building construction at Molesworth Street Car Park is £1,392,000 (no contingency) based on a cost of £4,000/m^2. However, if the energy centre is designed to a higher specification with additional architectural complexity, the costs would increase, resulting in a reduced 40 year IRR. For example, a 30% increase in energy centre costs to £5,200/m^2 would result in an increase of circa 4% on the overall CAPEX and a reduction in phase 2 40 year IRR from 8.8% to 8.1%. Alternatively, if energy centre build costs reduced by 30% to £2,800/m^2 (a CAPEX decrease of 4%), the IRR would increase to 9.4%. Figure 49 shows the impact of a variance in capital costs over the 40 year IRR for the Phase 2 network.

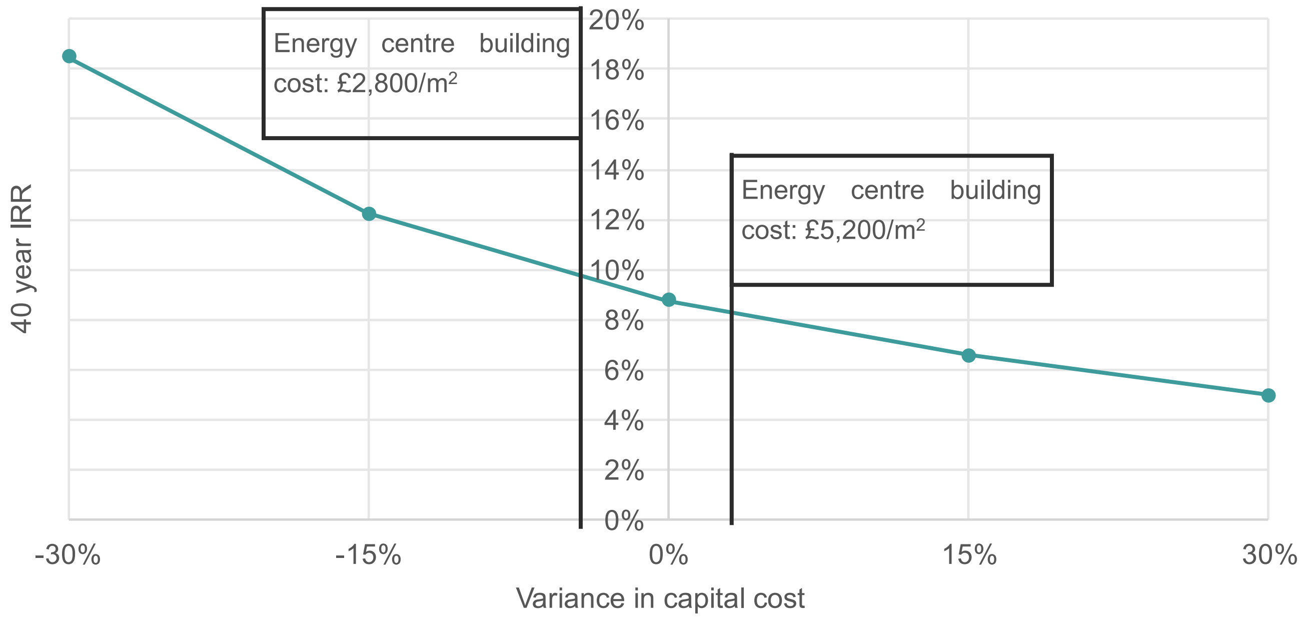

Figure 49: Effect of variance in capital cost

10.4 Green Heat Network Fund

Figure 50 shows that grant funding improves project viability and helps the network achieve IRRs suitable for private sector investment. With just 18% grant funding, the 40-year IRR would reach 10%.

A grant of 35%, equivalent to £5,483,858 and 1.5p per kWh for total heat delivered over 15 years, was used in the assessment and is presented in the conclusions.

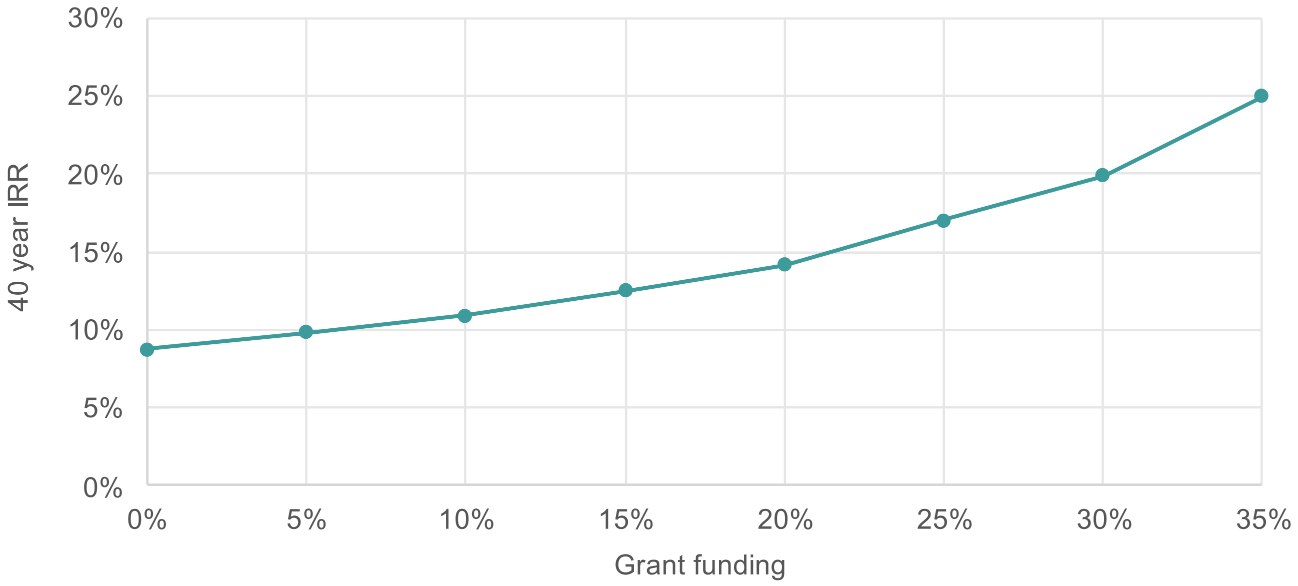

Figure 50: Variance in grant funding

10.5 Heat Demand

Figure 51 shows the effect caused by a variance in total network heat demand (with no change in energy centre equipment) has on the full network 40-year IRR. This shows that the network only has a small sensitivity to an increase in heat demand, which reduces IRR as the electric boilers will have to compensate for more of the load. A heat demand reduction has a larger effect on the network since the equipment will not be fully utilised. This also shows that the heat pump is correctly sized for the heat demand on the network

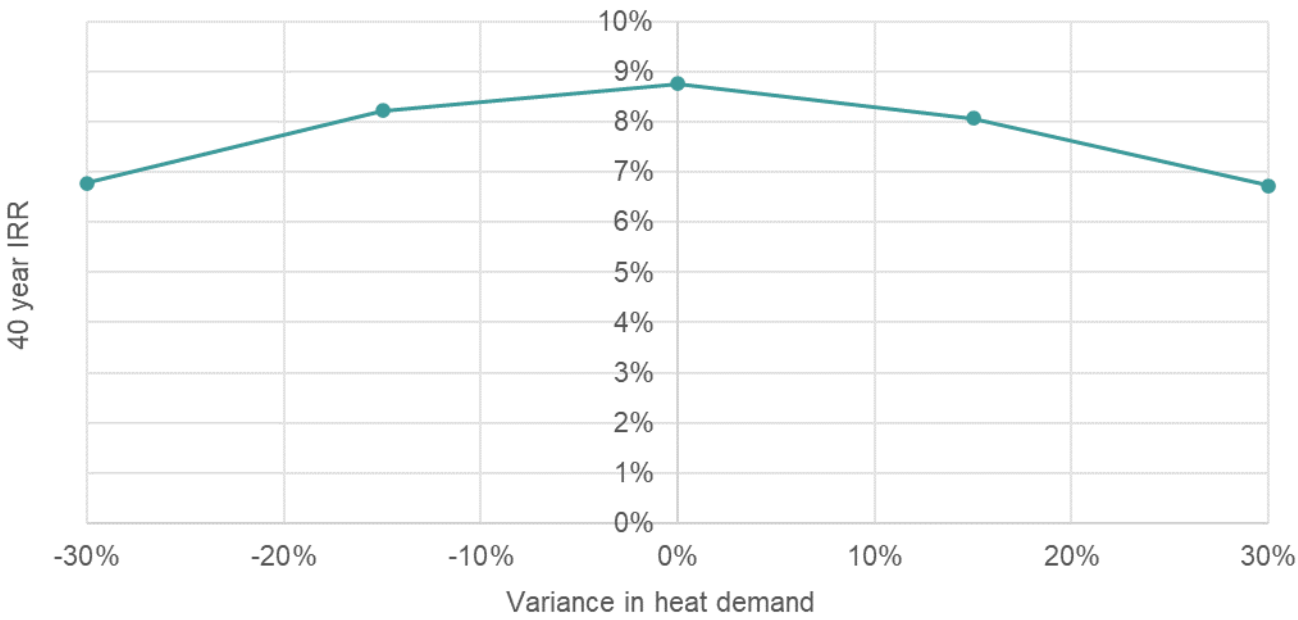

Figure 51: Effect of variance in heat demand

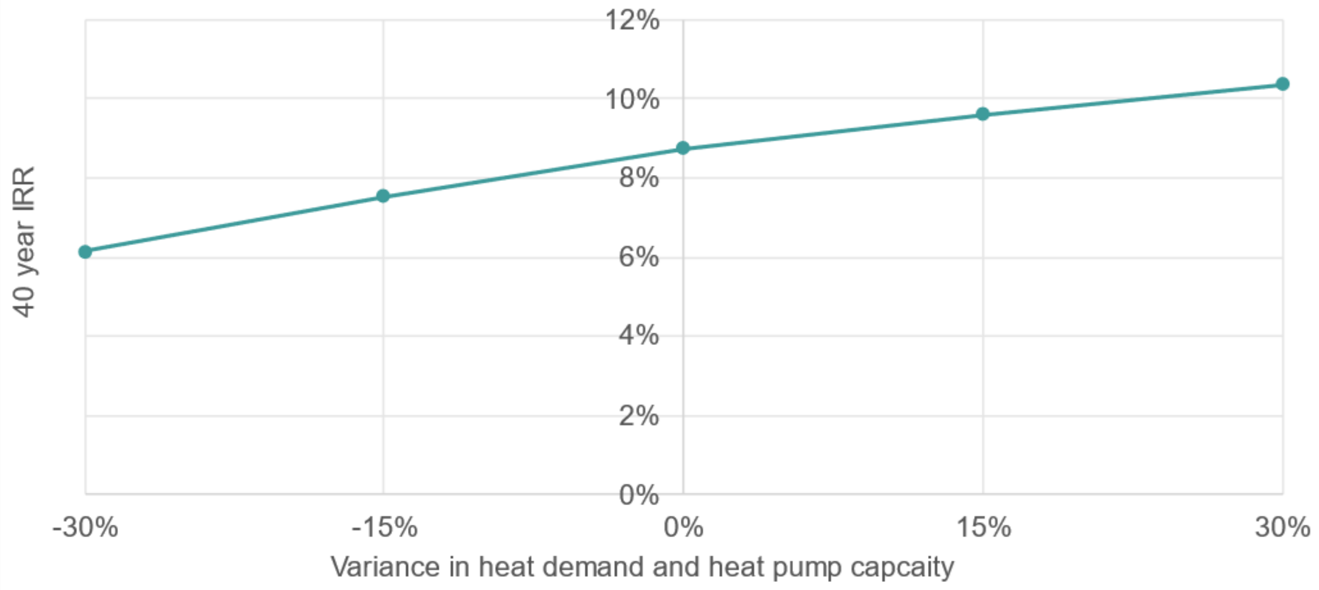

Figure 52: Effect of variance in heat demand and the corresponding heat pump capacity

Figure 52 shows the impact on the 40-year IRR if the capacity of the heat pump increases as well as the heat demand on the network. In this sensitivity analysis, a linear relationship is assumed (i.e., a 15% increase in heat demand corresponds to a 15% increase in heat pump capacity). This provides a high-level overview of the effects of variations in heat demand and heat pump capacity. The IRR increases with higher heat demand because the additional revenue outweighs the corresponding increases in CAPEX and OPEX.

Impact of buildings/networks not connecting to the Town Centre network

Table 23 shows the impact of the key sites not connecting to the Town Centre heat network. The reduction in IRR is primarily due to the loss of assumed heat connection fees and heat sales, while the energy centre's CAPEX remains unchanged.

If the E.ON network, along with neighbouring sites such as the Retail Park Development and Prendergast Vale School, do not connect, it would significantly impact the IRR, as that leg of the network represents a large portion of the overall heat demand. This would necessitate resizing the heat pumps and redesigning the energy centre to ensure that scheme with attractive returns is developed.

Table 23: Impact of key connections not connecting to the network

Heat demand scenarios	40 year IRR
Base case	8.7%
Shopping Centre Phase 1 Development not connected	6.5%
Shopping Centre Phase 1, 2 & 3 Development not connected	3.3%
E.ON Heat Network and Retail Park Development not connected	0.7%
Prendergast Vale School not connected	7.9%
E.ON Heat Network, Retail Park Development and Prendergast Vale School not connected	-0.5%
Gateway Phase 1 not connected	8.0%
Gateway Phase 2 not connected	7.3%
Gateway Phase 1 and 2 not connected	6.5%

10.6 Energy Tariffs

Electricity Purchase Tariff

The impact of variance in the energy centre electricity tariff is shown in Figure 53. For the base case assessment, an electricity supply tariff of 12.7 p/kWh was used. This has a significant impact on the 40-year IRR, as the network heat demand is met with heat generation systems powered by electricity.

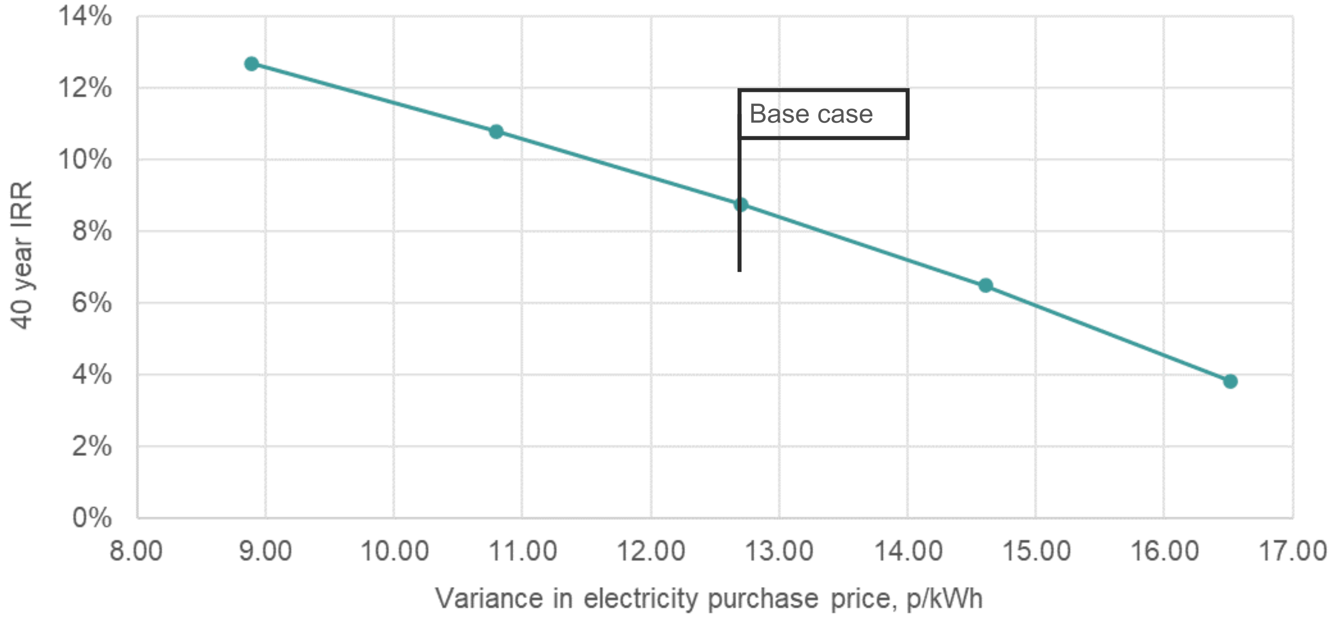

Figure 53: Effect of variance in energy centre electricity purchase tariff

Data Centre Heat Offtake Tariff

Figure 54 shows that the network is highly sensitive to the cost of heat from the data centre. A charge of 1p/kWh for waste heat purchase represents an annual increase in OPEX of £202,298. For the base case, it is assumed that waste heat from data centre will be free of charge. The methodology for the estimate of the heat required from the data centre is shown in 'Heat Taken Out of Heat Source' in 'Appendix 4: Key Parameters and Assumptions'.

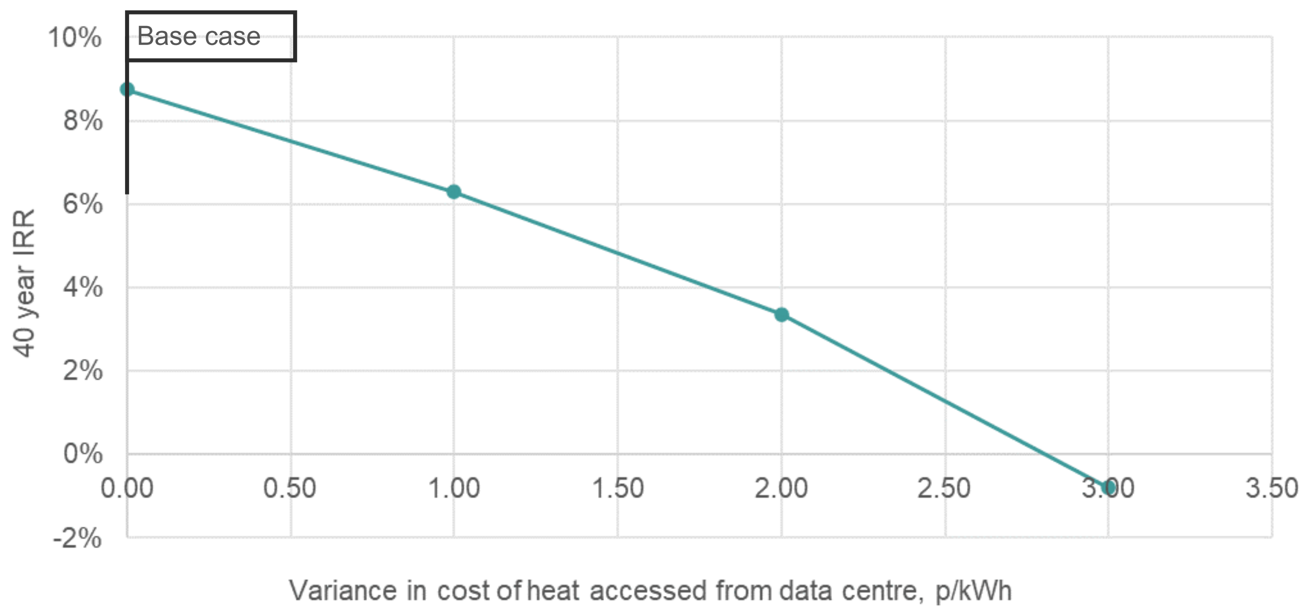

Figure 54: Variance in cost of heat from data centre

Heat Sales Tariffs (variable and fixed heat sale tariff element)

The heat sale tariff comprises two elements - a variable tariff of 9.01 p/kWh and a fixed tariff of £55/day. Figure 55 shows the effect of a variance in heat sales tariff the variable and fixed element.

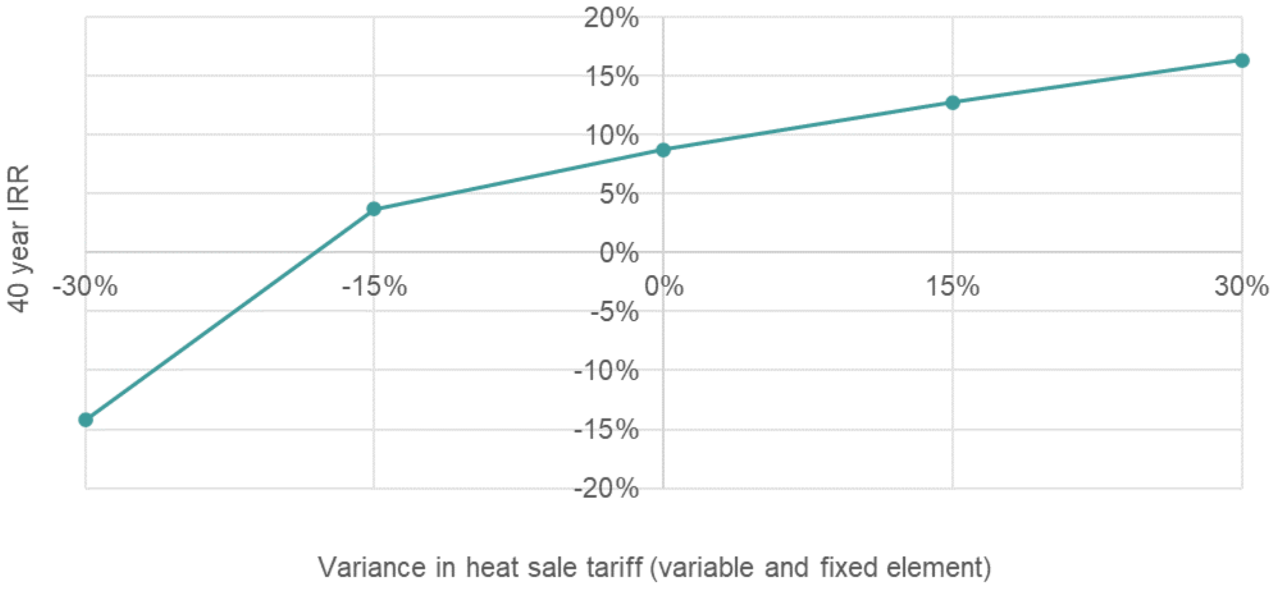

Figure 55: Variance in variable and fixed element of heat sales tariffs

Variable Heat Sales

Figure 56 shows the effect of a variance in only the variable element of heat sales tariff. It has been assumed as a base case that the variable element of the heat sales tariff will vary in line with the cost of electricity (based on the BEIS central scenario price projections for electricity). A 30% increase would result in a tariff of 11.71 p/kWh and an IRR of 15.9%. However, given the presence of multiple heat networks in Lewisham Town Centre, it is important to assess whether the tariff remains competitive after the increase.

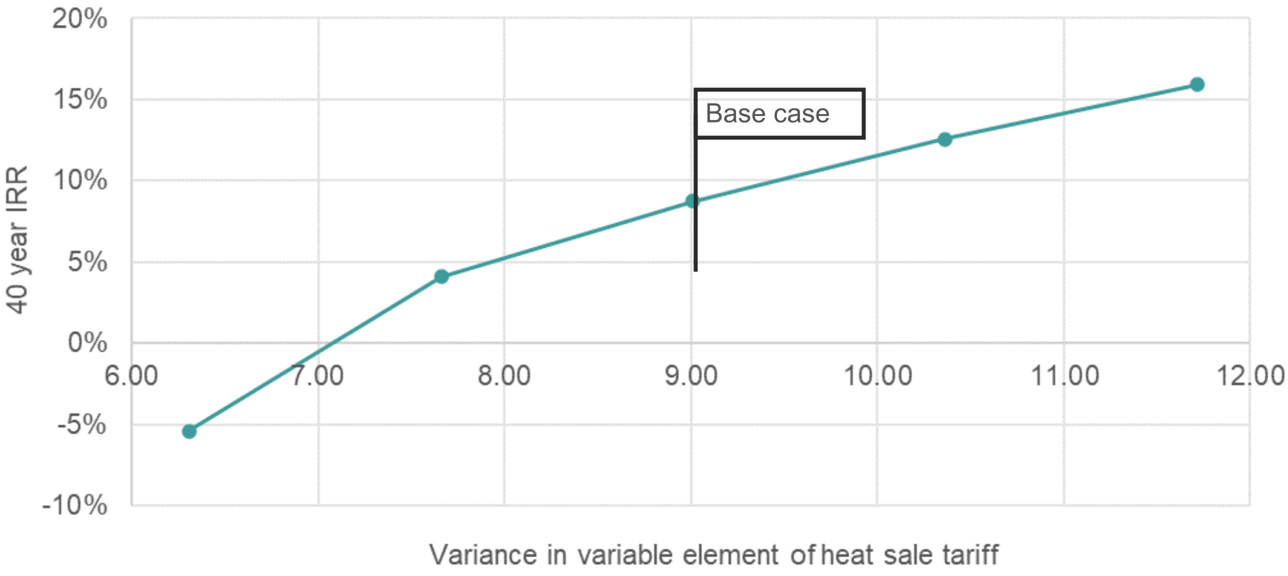

Figure 56: Variance in variable element of heat sales tariffs

Fixed Heat Sale Tariff

Figure 57 shows the effect of a variance in only the fixed element of heat sales tariff. A 50% increase would result in a tariff of 21.95 £/kW/day and an IRR of 9.6%.

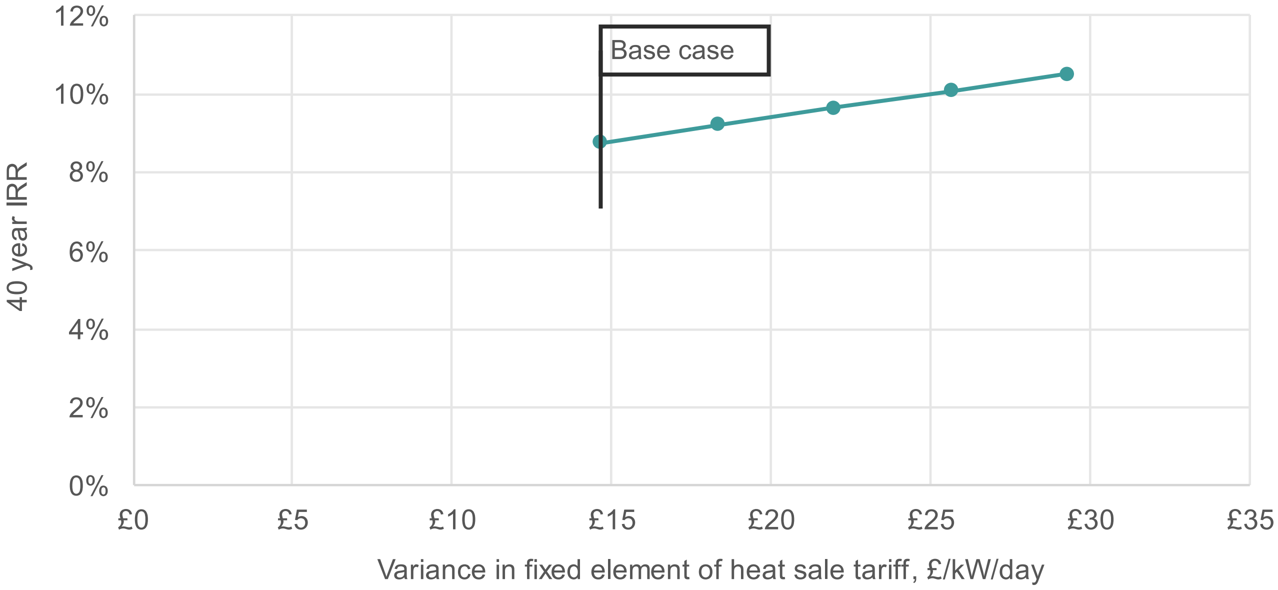

Figure 57: Variance in fixed element of heat sales tariffs

Heat Sales Tariff and Electricity Purchase Tariff

The impact of variance in heat sale tariff and energy centre electricity purchase tariff is shown in Figure 58. The figure shows that a variance in both the heat sales tariff and the energy centre electricity purchase tariff at the same rate significantly impacts network economics.

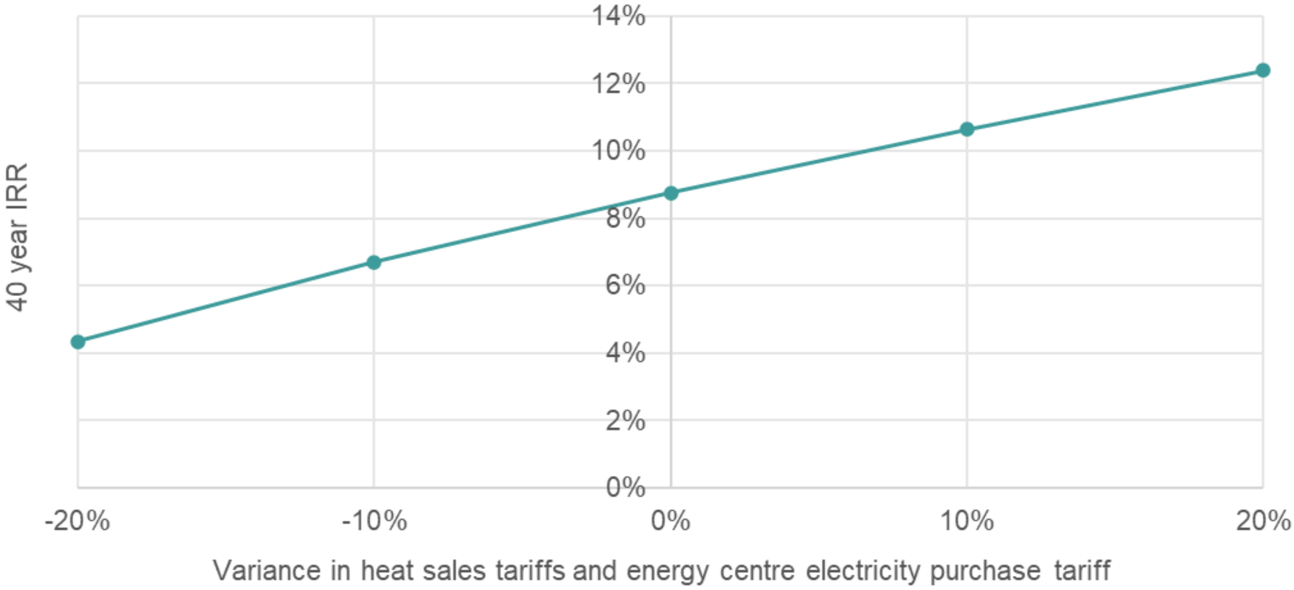

Figure 58: Variance in heat sales tariffs and energy centre electricity tariffs

10.7 Cooling Sale Tariff

Figure 59 represents the change in 40-year IRR if the network operator were to sell coolth to the data centre, this would bring additional revenue stream, and therefore improve network economics. It has been estimated that 15,118,464 kWh/year of coolth is available.

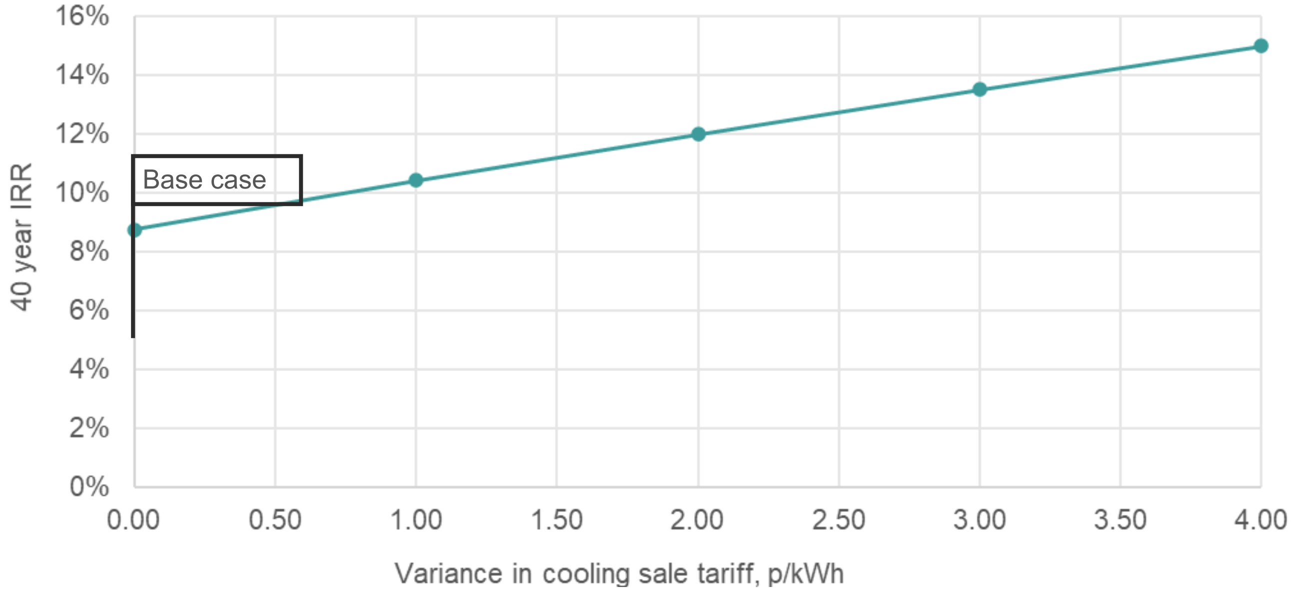

Figure 59: Effect of variance in cooling sale tariff

10.8 Energy Price Indexing

The impact of price indexing of all energy tariffs (is shown in Table 24. The 40-year IRR does not change significantly with different DESNZ scenarios, suggesting the network is resilient against changes in energy prices.

Table 24: Impact on 40-year IRR of indexing of all energy tariffs

Index for energy tariffs	40 year IRR
DESNZ central scenario	8.7%
DESNZ low scenario	8.2%
DESNZ high scenario	9.8%
Fixed rate: 0%	8.5%
Fixed rate: 3.5%	8.9%

10.9 Land Lease Costs

In the base case, no cost has been assumed for the use of the energy centre land, either in CAPEX or OPEX. Figure 60 shows the impact of potential land lease costs on the project 40-year IRR. Energy centre land fees above £100,000/annum significantly reduce the economic viability of the scheme.

Figure 60: Effect of lease of the energy centre land costs

10.10 Connection Charges

Figure 61 shows the effect that varying the connection charges has on the network. The charge used for the base case is £750/kW of connection capacity required. A 15% increase (to £862.50/kW) results in an increase of IRR to 10.1% whilst a 15% decrease (to £637.50/kW) results in a decrease of IRR to 7.6%. This illustrates how sensitive the network economics are to the connection charges, a large proportion of which come from the larger anchor loads which have high peak demands.

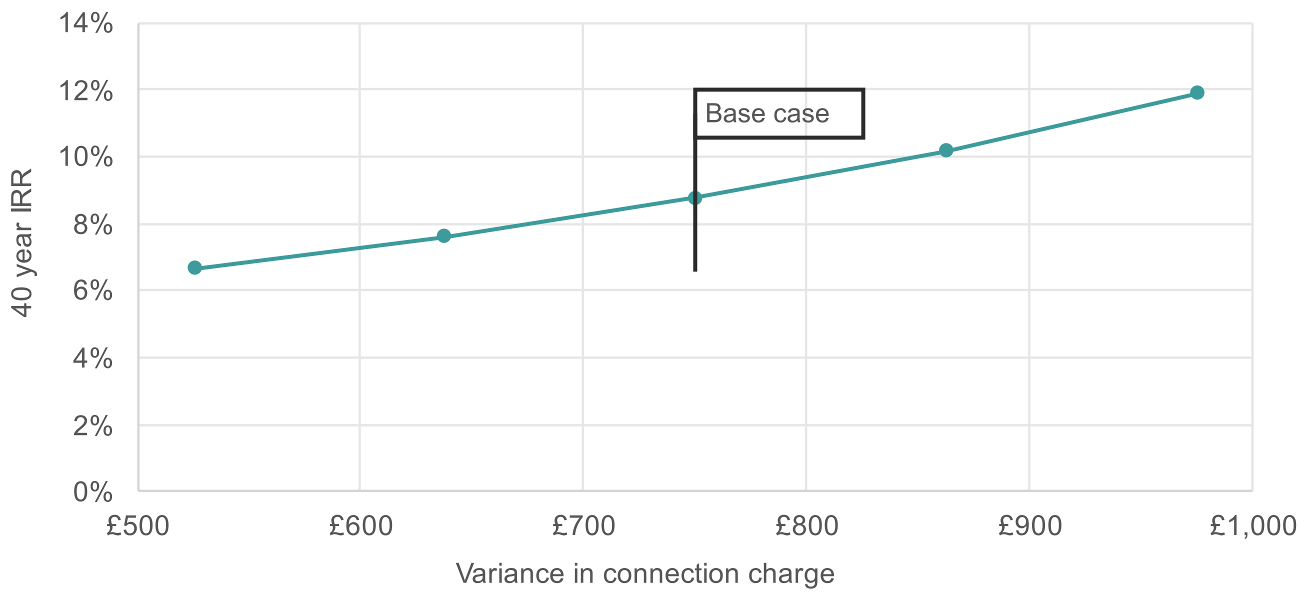

Figure 61: Variance in connection costs for commercial connections

10.11 Heat Pump SPF_{H2}

The impact of variance in the SPF_{H2} of the heat pumps is shown in Figure 62. SPF_{H2} includes the electrical consumption related to the heat pumps only. An increase in SPF_{H2} represents a decrease in electrical demand for the heat pump, and therefore a reduction in OPEX costs. The SPF_{H2} used for the base case is 3.87, based on 35°C heat offtake available from data centre. A 15% increase to 4.46 results in an increase to IRR to 10.1% whereas a 15% decrease to 3.29 results in a decrease to IRR to 6.8%.

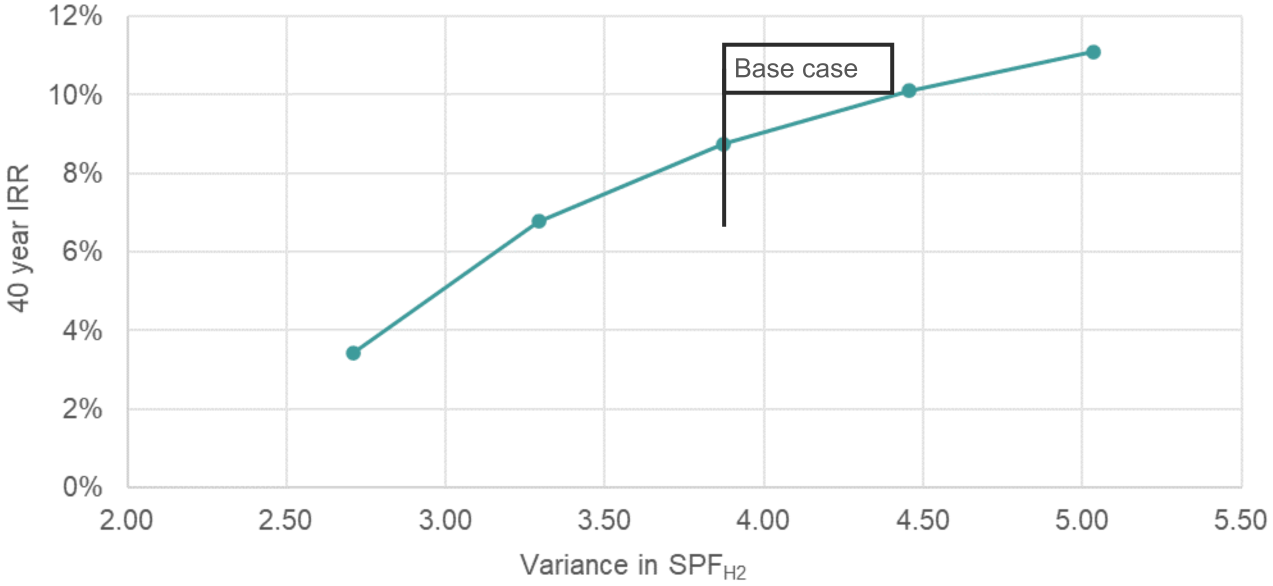

Figure 62: Impact of variance in heat pump SPF_{H2}

10.12 Peak and Reserve Boilers

The base case assumes electric peak and reserve boilers are installed to meet the network heat demand during the coldest periods and times of equipment failure and/or maintenance. Table 25 shows the impact of utilising E.ON's (5.7 MW) and Gateway Phase 2's (5.5 MW) existing gas boiler capacities to supply the peak demand instead of using electric boilers.

Table 25: Sensitivity on peak and reserve boiler technology

Sensitivity	Solution A
40 year IRR with electric peak and reserve	8.7%
40 year network emission with electric peak and reserve	8,878 tCO_2e
40 year IRR with gas peak and reserve	10.8%
40 year network emissions with gas peak and reserve	25,407 tCO_2e

The network economics would improve, due to the lower cost of gas, however, the network emissions would increase.

10.13 Summary

Key sensitivities for the network include:

- Capital cost
- Energy tariffs including heat sales tariffs and energy centre electricity purchase tariffs as well as potential waste heat purchase costs
- Sale of cooling to data centre
- Heat pump SPF
- Peak and reserve boiler technology

11 ENVIRONMENTAL BENEFITS AND IMPACTS

CO_2e intensity projections for grid electricity and natural gas are shown in Figure 63. The CO_2e emissions for the electricity grid are expected to reduce over time due to the increase in wind, solar and nuclear power and the closure of coal power stations.

Two CO_2e projections for grid electricity have been used in the TEM[3]:

- Long run marginal figure (commercial)
- Long run marginal figures (residential)

The long run marginal emissions factors consider the marginal plant for electricity generation. The projections are based on assumptions of future economic growth, fossil fuel prices, electricity generation costs, UK population and other key variables which are regularly updated. They also give an indication of the impact of the uncertainty around some of these input assumptions. Each set of projections takes account of climate change policies where funding has been agreed and where decisions on policy design are sufficiently advanced to allow robust estimates of policy impacts to be made.

These figures have been used for all electricity imported from the grid (i.e., for heat pump, electric boilers and energy centre ancillary electricity demand).

The long run marginal figures for grid electricity and the natural gas figure[4] have been used for the counterfactual CO_2e emissions.

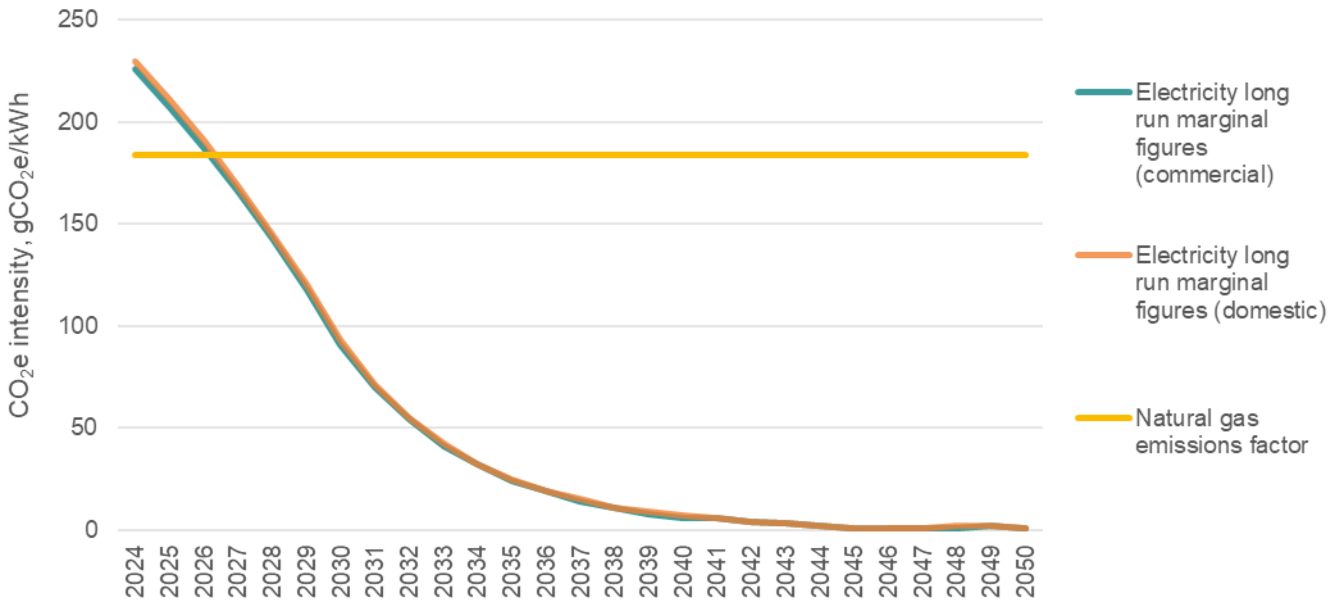

Figure 63: CO_2e intensity projections for grid electricity and natural gas

[3] https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

[4] https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2022

11.1 CO_2e Assessment

The network CO_2e emissions and carbon intensity for the Lewisham Town Centre Network are shown in Figure 64 and Table 26.

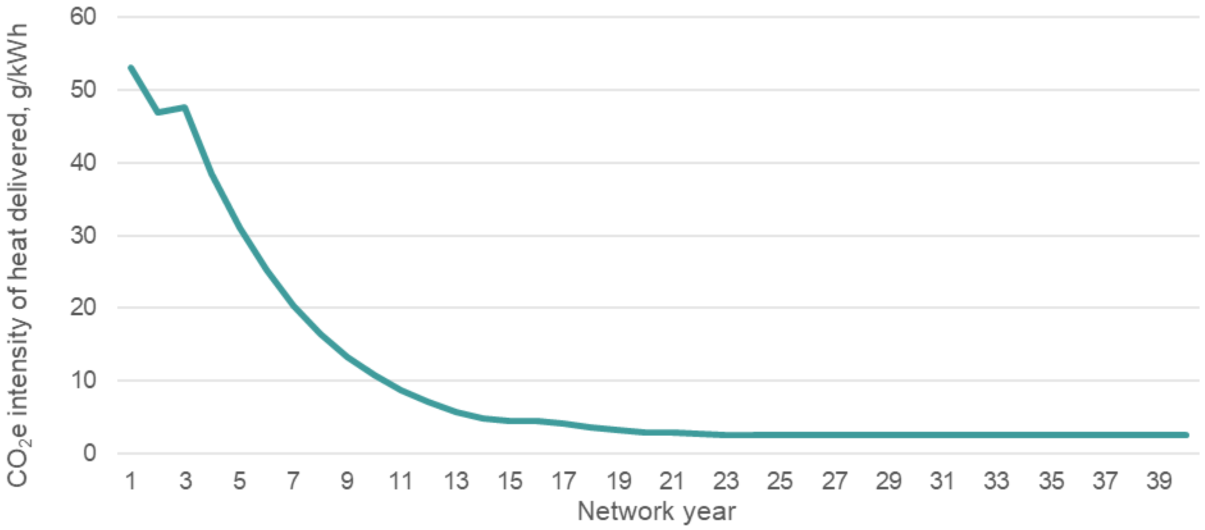

Figure 64: 40-year network CO_2e intensity

Table 26: Network CO_2e emissions and intensity over 25, 30 and 40 years

CO_2e emissions and intensity		
25 years	Network CO_2e emissions, tCO_2e	7,857
30 years	Network CO_2e emissions, tCO_2e	8,198
40 years	Network CO_2e emissions, tCO_2e	8,878
First year CO_2e intensity of delivered heat, g/kWh		53
CO_2e intensity of heat delivered (40-year average), gCO_2e/kWh		10

11.2 Social IRR and NPV

The social IRR and social NPV help to identify the wider benefits of the scheme for the community and are a vital consideration for local authorities. The social IRR and NPV are shown in Table 27 and are determined by monetising the CO_2e savings and the improvements in air quality against the use of individual gas boilers. The economic value of the carbon and air quality improvements are included in the project cash flow and are based on DESNZ projections[5]. These account for the reduction in future costs of mitigating the effects of climate change, and the reduction in healthcare costs associated with the improved air quality by removing gas boilers across the city.

Table 27: Social IRR and NPV for the Phase 2 network (without funding)

		IRR	Social IRR	NPV	Social NPV
Phase 2	25 years	8.1%	23.6%	£4,871,370	£33,623,252
	30 years	8.5%	23.5%	£6,199,076	£39,434,749
	40 years	8.7%	23.4%	£8,170,397	£48,388,461

[5] Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal - GOV.UK (www.gov.uk) – Data tables 3 and 15

12 COMMERCIAL DELIVERY MODELS

This section outlines the longlist and shortlist of the commercial delivery models considered for the project, drawing on insights gathered through engagement with key council stakeholders. The discussions aimed to identify delivery approaches that align with the council's strategic objectives, financial parameters, and risk appetite.

12.1 Longlist Options

This section summarises four commercial delivery models that were considered for Lewisham Council; in order of most to least Council involvement required, these comprise Lewisham Council Self-Delivery, Joint Venture, Concession and Private Sector Led. These commercial delivery models exist on a spectrum (as can be seen in Figure 65), and a combination of two neighbouring models can be considered.

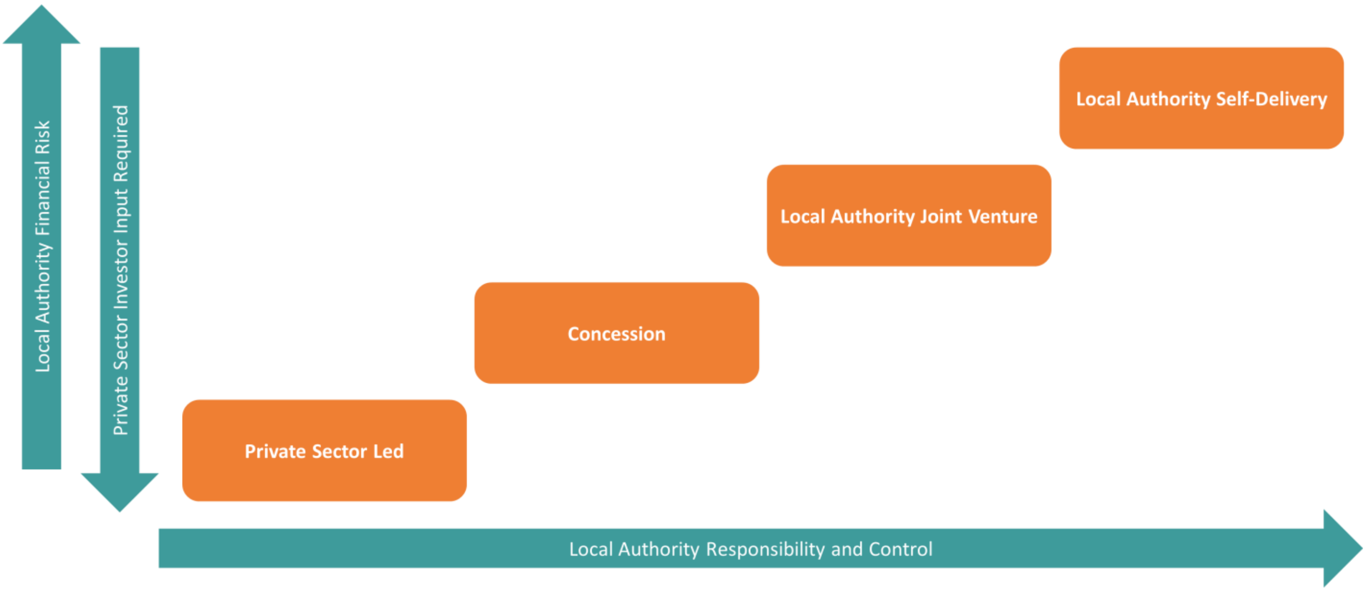

Figure 65: Spectrum of Commercial Delivery Models

12.1.1 Lewisham Council Self-Delivery

Under this delivery model, the local authority normally wishes to supply a group of buildings under its direct ownership or control, often reflecting approaches undertaken by universities, colleges and NHS Trusts, who have a large number of buildings that require a significant amount of heat on a single campus, rather than a wider district heat network.

The local authority manages the project though the letting of Design & Build (D&B) and Operation & Maintenance (O&M) contracts (or combined ‘DBOMs’), and typically funds the project from its own balance sheet, alongside grants and public debt e.g. the Public Works and Loans Board (PWLB). The local authority will often set up a public-owned delivery vehicle to which it transfers the heat network assets, effectively setting up and owning a new Energy Services Company (ESCo), whether via an arm’s length SPV or not. This is illustrated below.

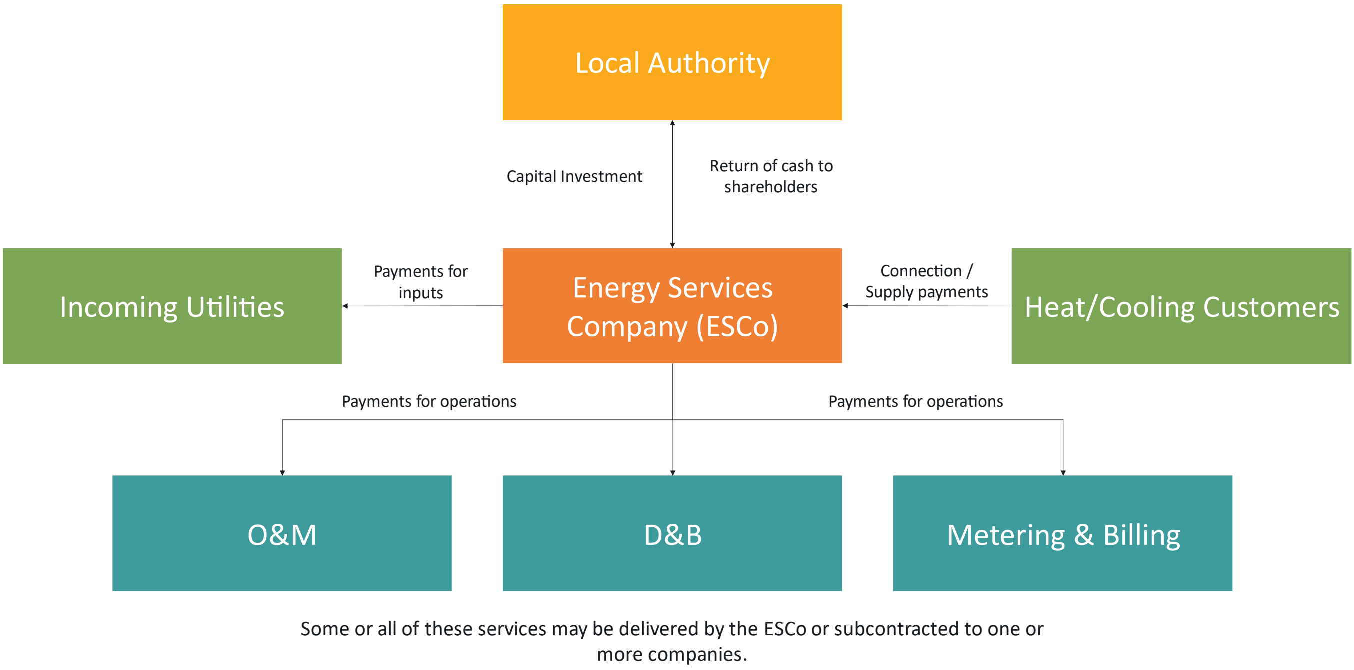

Figure 66: Lewisham Council Self-Delivery

12.1.2 Joint Venture

Under this model, the local authority partners with the private sector with whom it enters into a joint venture (JV) agreement. In doing so, the local authority and private sector partner co-invest in a new corporate entity, and its financial returns (or losses) are shared according to their respective investments.

Most JVs involve the establishment of a new company, and include a number of contracts (notably, a shareholders' agreement) which detail the governance arrangements, each partners' financing obligations and the services to be provided. Importantly, the shareholders' agreement will have to include a provision for how the JV can be dissolved.

Note: the dotted lines in the following figures denote the governing legal agreement in place.

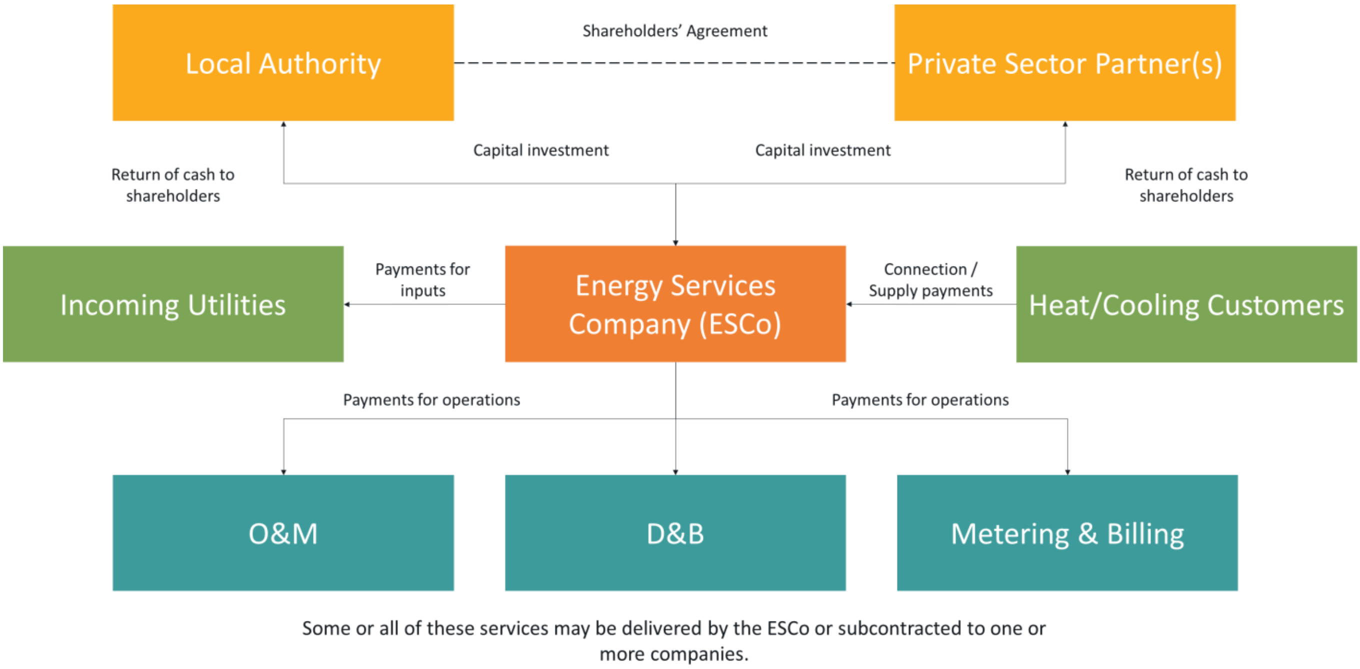

Figure 67: Joint Venture

Shareholder's Agreement

The governing legal agreement in this commercial model is the shareholder's agreement; this sets out the terms on which the public sector and private sector partner will govern the joint venture (JV). The shareholders' agreement will cover standard representations (i.e. incorporation, powers, enforceability of obligations etc) and warranties, necessary board meetings, a list of reserved matters, provisions for terminating the JV, legal agreements and boilerplate terms.

12.1.3 Concession

Under this delivery model, the local authority grants a private sector supplier an exclusive right to provide heating and/or cooling services through a concession agreement. In return, the private sector supplier usually designs, constructs, finances and operates the heat network within a defined area for a defined period of time.

The Council retains some governance over the heating and/or cooling services to be provide though the concession agreement, including performance standards, heat and/or cooling tariffs, and heat and/or cooling offtakes. Meanwhile, the concessionaire finances the project, taking on substantial financial risk and recouping its investment through income generated from customer connection charges and heat sales.

Upon expiration or early termination of the concession, mechanisms are included for step-in and/or asset hand-back procedures, with responsibility (and ownership depending on the structure) usually reverting back to the local authority, which may be subject to a retendering event.

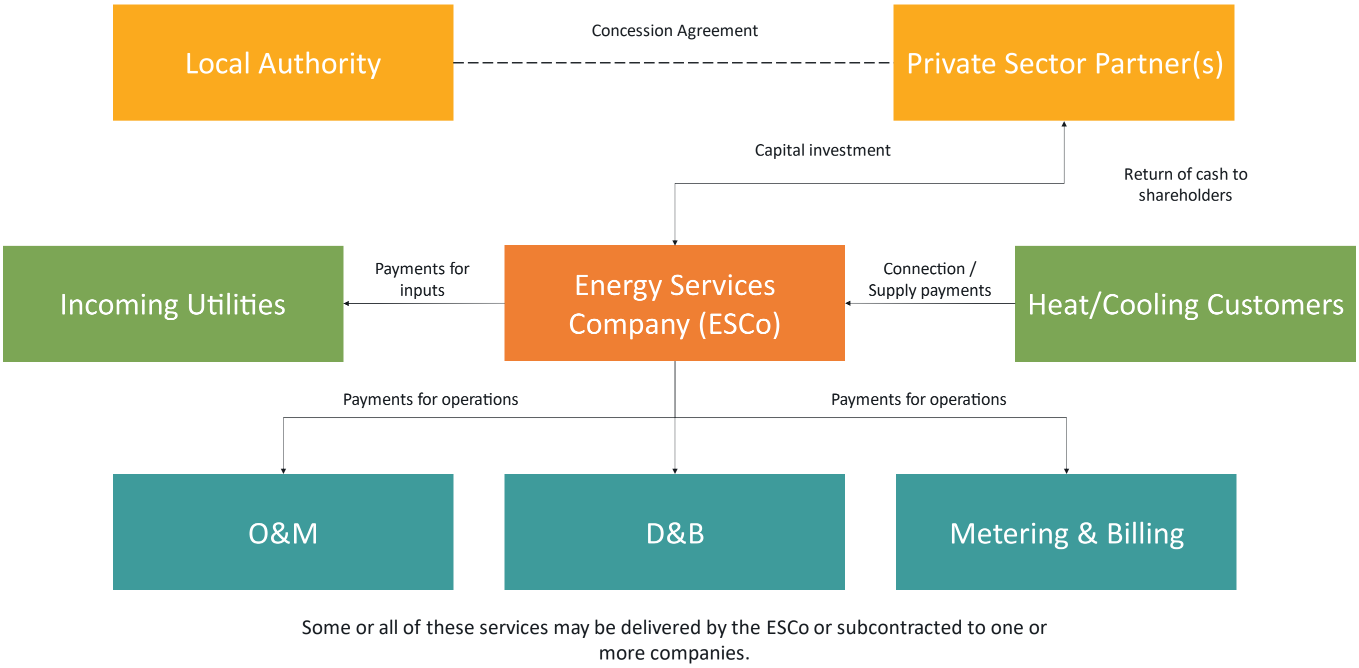

Figure 68: Concession

Concession Agreement

The governing legal agreement in this commercial model is the concession agreements which includes standard representations and warranties, concession obligations (i.e. details of the design, build, financing, operation and maintenance services to be provided), a performance regime and appropriate property rights and licences e.g. a form of lease for an energy centre and easements for networks with titleholders.

12.1.4 Private Sector Led

In this delivery model, the local authority has a limited or no role, other than facilitating or agreeing potential land agreements and, where necessary, securing public financing instruments e.g. grants, as well as entering into Energy Services Agreements and/or Heat Supply Agreements for any relevant council-owned buildings connecting to the scheme.

The ESCo is then solely responsible and liable for the development of the scheme, acting as a private utility or Energy-as-a-Service provider, with its own project finance (with no Council balance sheet impact).

Local authority governance of the scheme is limited to the terms of the agreements for services, and potentially land agreements, prior to incoming regulations anticipated in 2025 (Market Framework and Zoning Regulations).

There are also emerging models in the market in respect of procuring Development Agreements and/or Project Governance Agreements to engage the private sector with potentially accelerated procurement routes.

(Note: the items shown in Italics indicate that the local authority may or may not facilitate land agreements and make the public sector grant application on behalf of the private sector partner, acting as a project sponsor in this respect).

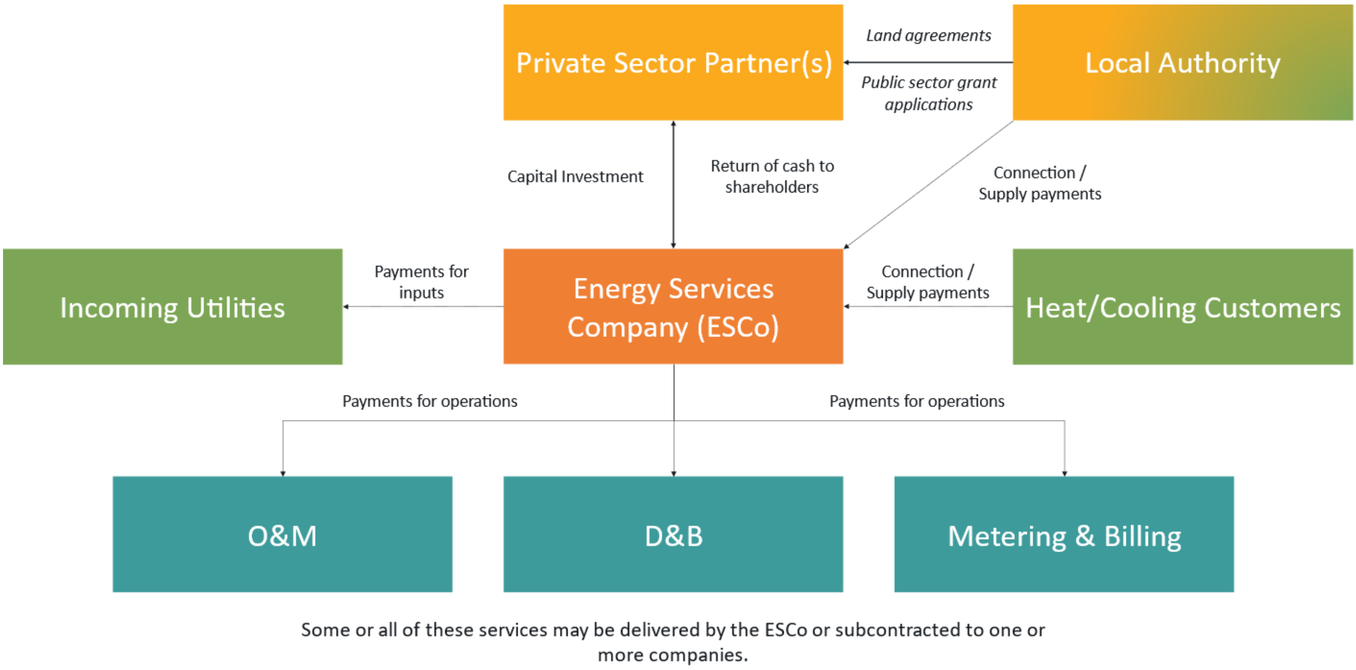

Figure 69: Private Sector Led

12.2 Shortlist Options

The key factors affecting the choice of delivery model are as follows:

- The Council is not going to provide any capital investment to the project
- The Council does not want to create a formal JV
- The Council would not be a major customer to the heat network, as there are no Council-owned buildings being proposed to connect
- The Council's major role is to enable the development of the network
- The Council is the owner of the prime locations for the energy centre
- Challenges of connecting to nearby incumbent networks
- The heat source for the project Riverdale Data Centre (heat offtake from data centre) provides additional challenges both for the data centre owner and also offtakers
- The Council wants the network to develop rapidly
- Potentially good financial viability

Based on the factors above, any options involving Council funding or material control have been ruled out, as a result, only private sector delivery options have been explored further. The shortlisted options, presented to the Council and assessed in more detail, are:

- Do nothing
- Prospectus-based approach
- Development Agreement

- Development Agreement and Golden Shareholders' Agreement

12.2.1 Prospectus Based Approach

Under this model, the Local Authority would publish a prospectus to the market outlining the opportunity to develop a heat network. The aim is to attract interest from the private sector, inviting developers or investors to come forward and progress the scheme independently.

The prospectus can be tailored to suit the Local Authority's preferences—ranging from a high-level summary to a more detailed technical and commercial overview. However, once published, the Local Authority has no control over whether the scheme is taken forward, who develops it, how it is developed, or how it is ultimately operated.

This model does not require a formal public procurement process, making it the least resource-intensive of the delivery options. It may suit situations where the Local Authority's role is limited to enabling or promoting low-carbon infrastructure, without taking on any direct responsibilities or risk.

12.2.2 Development Agreement

Under this delivery model, the Local Authority would appoint a development partner to design and develop the district heat network up to the point where it is ready for construction. At that stage, both parties would have the opportunity to decide independently whether or not to proceed. There is no obligation on either side to take the project forward beyond this point.

Once the development services have been completed, the contractual relationship between the Local Authority and the development partner comes to an end, regardless of whether the project continues.

The procurement process for this approach could typically be completed within four to six months, depending on internal approval processes and the number of bids received.

While the Local Authority can influence the development stage via participation in a steering group and project approval gateways, it does not hold a share in any delivery organisation (eg SPV) and will not have any formal involvement in delivery or operation. As a result, ongoing resource requirements are minimal. Since the contract value under this model is limited to the development services fee, it is not classified as a concession arrangement.

12.2.3 Development Agreement and Golden Shareholders' Agreement

This model follows the same initial structure as the standard Development Agreement approach, taking the project up to the point where the heat network is ready for construction. However, unlike the previous model, the contractual relationship between the Local Authority and the development partner does not end at financial close.

If the project is approved, the Local Authority would enter into a Shareholders' Agreement with the development partner. This agreement establishes an SPV to deliver the project, in which the Local Authority holds a single "special" or "golden" share.

The procurement process for this model is expected to take approximately nine to twelve months, depending on internal approvals and the number of bids received.

This delivery structure enables the Local Authority to remain actively involved throughout both the development and operational phases of the project. Influence is maintained through participation in a steering group and the use of key project approval gateways. As a shareholder, the Local Authority would also gain certain contractual rights. These include the ability to block specific decisions requiring joint shareholder consent, as well as the right to appoint an observer to attend and speak (but not vote) at SPV board meetings. The golden share does not carry any economic rights. This means the Local Authority would not share in any financial returns generated by the project, but likewise, it would not be required to make a significant financial contribution to the SPV. As a result, the Local Authority's investment risk is minimal.

12.3 Summary

The three delivery models: development agreement only, development agreement with golden shareholders' agreement, and the prospectus based approach, as well as the 'do nothing' scenario, are summarised in Table 28 in terms of the level of control retained by the Local Authority, the resource required, and the anticipated speed of delivery.

Table 28: Shortlisted delivery models summary

	Do nothing	Prospectus based approach	Development agreement	Development agreement and golden shareholders' agreement
Control	• No control over who develops the scheme, how the scheme is developed or how it is operated	• No control over who develops the scheme, how the scheme is developed or how it is operated	• Control over who develops the scheme • Limited control over how the scheme is developed • No direct control over how the scheme is delivered / operated	• Control over who develops the scheme • Limited control over how the scheme is developed • limited control over how the scheme is delivered / operated
Resource	• Least resource required. Does not require a public procurement	• Relatively little resource required for the development of prospectus • No public procurement exercise required	• Public procurement required and increased level of resource required. Note requirements re potential development costs	• Public procurement required and the highest level of resources required. Note requirements re potential development costs
Speed of delivery	• Least likely to result in the scheme being delivered	• Low level of influence over speed of delivery • A similar approach has previously been utilised in respect of E.ON but not resulted in the project being delivered.	• Council can influence the procurement process and development period but not the delivery / operational phase	• Council can influence the procurement process and development period • Procurement period likely to take longer than for Development Agreement only

Following consideration of the delivery model options and discussion during the commercial options workshop, the Council has confirmed a preference for the prospectus based approach. This decision reflects the Council's limited resources and its intention to minimise direct involvement in the delivery and operation of the scheme.

The next steps are to develop and publish the prospectus to promote the opportunity to the market. In parallel, further work will be carried out to assess the value of the proposed energy centre land but with consideration of maintaining the commercial attractiveness of the scheme to potential developers.

13 LEWISHAM COUNCIL ROLE

13.1 Energy Centre (and Networks) Land

Regardless of the commercial delivery model selected and the extent of Lewisham Council's ongoing role with the heat network, Molesworth Street Car Park (for which the Council has a freehold title) has been identified as a key potential project enabler as the potential site of the energy centre. The ESCo would typically acquire or lease the site to deliver the scheme.

13.2 Stakeholder Engagement

Considering the technical solution proposed and the Council's commercial preferences, it was concluded that the development approach from a Council perspective needs to focus on the stakeholder 'commercialisation' of the scheme i.e. understanding how the existing commercial operations and parties could feature in a new low carbon district heat network e.g.

- **Existing gas-CHP operators** – E.ON Loampit Vale network, SDCL/EECO energy centre serving the data centre, and Lewisham Gateway mixed use development ESCo
- **Data centre** – Citibank's Riverdale data centre, as a potential heat source and/or cooling customer
- **Landsec redevelopment** – major development of retail centre as an anchor customer directly opposite the data centre

To that end, these parties (amongst others) were engaged with to judge their commercial appetite.

Please see Section 2.2 Stakeholder Engagement for additional key commercial findings.

13.3 Funding Options

Heat networks have traditionally been funded from the balance sheet of large industrial organisations (e.g. ENGIE, E.ON, SSE, Veolia). However, heat networks have increasingly begun to attract different forms of equity-led project finance, including infrastructure fund-backed development platforms like DIF (via Hemiko), Asper (via 1Energy) and Partners Group (via Gren).

Projects often also benefit from public sources of finance, such as DESNZ grants. Key routes of such blended finance approaches are summarised in Table 29 (non-exhaustive). If the project progresses to the next stage, a detailed preferred funding strategy will be developed, it should be noted however that existing key stakeholders in the project, E.ON and Sustainable Development Capital Limited (SDCL) may have an interest in funding the scheme.

E.ON could provide a more streamlined route to securing funding and getting pipes in the ground because they already operate the Loampit Vale heat network. Hence, it is recommended that the Council includes E.ON in all continued market engagement as a potential funder and ESCo, if the procurement for a private sector partner goes ahead.

SDCL are also in a good position to invest in the scheme as they are the ultimate owners of the Riverdale data centre energy centre and should therefore also be able to speed up the process of securing funding. Therefore, it is recommended that SDCL are engaged on two fronts:

- as a prospective external investor, and
- as a potential co-partner with the GLA in the EDGE fund

In addition to the above, soft market testing should be carried out with other suitable investors to provide Lewisham Council with a range of private funding options; conversations can also be arranged with the organisations responsible for viable public sector options (e.g. Triple Point).

13.3.1 Grants

Lewisham Council could consider applying for the GHNF (the only remaining announced round is estimated to close in January 2025). Note also that the GHNF is also available to the private sector partner, and hence funding does not necessarily have to flow through the Council (with respective on-grant considerations including clawback risk and balance sheet implications). Either way, the eligibility of the technical solution and viability of receiving funding should be assessed, noting that the private sector partner may develop a different solution.

Importantly, public sector grant funding will also have a positive impact on the IRR, and thus improve market attractiveness. In the financial model, different grant funding amounts and private funding options will be tested. The financial case will then summarise sensitivity analyses on returns, and therefore consider the risk of taking to market with/without grant.

Table 29: Public sector funding options

Funding Option	Description
The Green Heat Network Fund (GHNF)	The GHNF is a multi-year £485 million capital grant fund that supports local authorities and energy companies with the construction and commercialisation costs associated with heat networks. It is designed for new low and zero carbon heat networks, as well as the retrofitting and expansion of existing heat networks. It is worth noting that, amongst other criteria, the maximum grant available is limited by the cost and amount of low carbon heat delivered in the first 15 years. The next round is expected to open in Autumn 2025; however, the exact criteria and dates are currently unknown.
The Public Sector Decarbonisation Scheme (PSDS)	The PSDS provides grants to public sector bodies to fund decarbonisation and energy efficiency measures. The scheme has up to £670 million of funding available in 2025 to 2026 and £300 million in 2026 to 2027. Phase 4 (guidance to be published in Autumn 2024), will be different from previous, allowing for an application assessment process rather than the previous first-come-first-served policy.
The Public Works and Loans Board (PWLB)	The PWLB lending facility provides loans to local authorities from the National Loans Fund. Standard borrowing from the PWLB is at Gilts + 1% (or 100bps). Authorities who submit annual forward plans for borrowing can benefit from the Certainty Rate i.e. Gilts + 0.8% (or 80bps). New rule changes, introduced in 2023, restrict local authorities from borrowing from the PWLB for financial return, aimed at restricting authorities acquiring commercial / retail properties whose value might later decline. N.B. Gilts are bonds issued by the UK government. They are essentially a very low-risk bond. A Bp (or Basis Point) is simply a common unit of measure for interest rates. Typically, used in finance to remove some of the ambiguity when talking about percentage changes.
UK Infrastructure Bank (UKIB)	The UKIB has allocated £4 billion of infrastructure finance to help tackle climate change. The UKIB provides loans to local authorities at Gilts + 40bps. The minimum ticket size for a loan from the UKIB is £5 million.
UK Municipal Bonds Agency (UKMBA)	The UKMBA is a vehicle set up by the Local Government Association (LGA) to borrow money to lend to local authorities. The UKMBA offers three main lending programmes: (1) pooled loans of £1 million or more for maturities greater than one year (loans are proportionally guaranteed). (2) standalone loans to a single Council for £250 million or more for maturities greater than one year (loans are outside of the proportional

Funding Option	Description
	guarantee and are guaranteed solely by the borrower). (3) short term, pooled loans for maturities of less than one year (outside of the proportional guarantee). Borrowing from UKMBA has been limited, primarily because market conditions have not delivered price savings relative to the more accessible PWLB.
The Mayor of London’s Energy Efficiency Fund (MEEF)	The MEEF is a £500 million investment fund established by the Greater London Authority (GLA) and backed by Amber Infrastructure Group. It seeks to provide flexible and competitive finance to accelerate or enhance viable low carbon projects across London. Investments are for projects of £500,000 and above.
The Mayor of London’s Green Finance Fund	The Mayor of London’s Green Finance Fund was established to lend up to £500 million to projects that help London meet its net zero ambitions. The fund may offer loans with interest rates 20bps lower than PWLB interest rates. The minimum ticket size is £1 million.
The London Efficient and Decentralised Generation of Energy Fund (EDGE)	The EDGE fund is a £100 million fund designed to accelerate London-wide decarbonisation. In partnership with Sustainable Development Capital LLP (SDCL), the Mayor of London’s EDGE Fund will focus on energy efficiency, on-site generation and clean energy solutions, aiming to facilitate the installation of building management systems, heat pumps, solar panels, and electric vehicle charging.

14 PROCUREMENT ROUTES

Lewisham Council will need to consider how far to continue development of the scheme before engaging the market, either through a formal procurement process or alternative route. This will be highly dependent on the Commercial and Financial Case options pursued.

Key considerations should include the level of resource capacity within the Council and/or availability of funding/support from other sources e.g. DESNZ Heat Networks Development Unit, or Low Carbon Skills Fund; GLA Local Energy Accelerator; or alternative sources.

It should also not be assumed that 'direct market entry' means zero/minimal requirement from Lewisham Council as by nature, even as an enabler, a potential customer, and a landlord, there will be a draw on internal resources and likely requirement for advisory support (financial, commercial, legal, and technical) to varying degrees and potentially under different fee structures. The approach to a GHNF application could also be a key decision maker on how far to develop the scheme and approach the market.

Either approach discussed below would naturally lean the Council towards a delivery model which will have a level of private sector investment, however if the Council wants to retain control over elements such as the design, this will necessitate more project development before going to the market

14.1 Direct Market Entry

For the Lewisham Town Centre Network, the Council is not offering large public sector loads to pool heat supply agreements, or at this stage expecting to be a co-investor of the scheme. There is also limited Council housing stock likely to be directly affected, which is one reason for not expecting a high degree of control or governance over the scheme.

To that end, a direct market entry approach could be centred around the availability of land for an energy centre, such as at Molesworth Street Car Park. This could form the basis of a market selection process where the land is marketed (e.g. a land disposal prospectus or Information Memorandum (IM) approach) to the heat network developer/investor(s) in order to drive competition and see what the market offers in terms of carbon reduction and tariffs (linked to investors cost of capital, amongst other variables) to best meet Lewisham Council's CSFs. This approach is likely to be a comparatively low-cost approach for the Council and should achieve best value requirements without the need for a potentially complex regulated procurement exercise e.g. Concession Contract Regulations.

However, as per the stakeholder engagement work undertaken to date, there is significant risk associated with Molesworth Street Car Park, given Transport for London's Title Restriction in relation to the bus stand relocation for the anticipated Bakerloo Line Extension, which is being investigated by the team.

For additional technical and commercial discussion on Molesworth Street Car Park, see Section 5.

Alternatively, the heat generation plant could be located across other sites, either on a decentralised basis, or with a primary energy centre from within the existing E.ON network, or the Landsec redevelopment; this may reduce or change the Council's role in the development, unless and until designated as a Heat Network Zone Coordinator, which is under consideration by the Council together with the GLA and subject to the results of the current consultation.

14.2 Frameworks (BHIVE)

Frameworks, such as the BHIVE - DESNZ Heat Investment Vehicle (a government-recognised, Public Contracts Regulations (PCR) compliant procurement platform), could help the Council connect with a private funding partner more quickly. BHIVE is a procurement platform though which a heat network project is offered to an array of private sector partners who have been specially selected by the delivery team to provide private finance – equity or asset finance. BHIVE as a potential route has been excluded at this stage, given that there is no desire from the Council to form an incorporated joint venture.

Disclosure: Amberside Advisors are part of the DESNZ / Triple Point Investment Management delivery team for the BHIVE Dynamic Purchasing System platform.

14.3 Developed Market Entry

Under this approach, the Council would spend more time developing the fundamentals of the heat network project i.e. getting planning permission for the energy centre, carrying out extensive stakeholder engagement / soft market testing, taking the design to RIBA stage 2 and/or finalising the design, and potentially preparing a full business case.

By developing the heat network project in this way, the Council would ensure that the project is suitable for public sector grant applications. Hence, this approach is generally more common in greenfield projects, and when the Council wishes to retain asset control, or when the project requires grant funding to attract the private sector to participate in the development of the scheme.

15 LETTERS OF SUPPORT

Informed by our discussions with these key stakeholders, Letters of Support were requested from:

- Lewisham Council
- Citibank
- Landsec
- E.ON
- The Greater London Authority (GLA)

As of the date of this report, signed Letters of Support have been received from the Council and E.ON, whilst the other stakeholders remain engaged but have not yet sent letters. Lewisham Council will be kept informed as these conversations progress.

Should the scheme progress to a full OBC, further investigation will be undertaken to confirm if these key stakeholders would sign Heads of Terms (HoT). As the stakeholder engagement has not progressed to the point where drafting HoT would be appropriate, these have not yet been fully developed. A template HoT (largely based on the Heat Network Delivery Unit template) has been provided in Appendix 5: Template Heads of Terms to provide the Council with a general understanding of the likely next step of progression.

Amberside will lead on the development of the HoT and negotiations with stakeholders as part of the next stage of project development. However when the HoTs need to form binding agreements, the responsibility will lie with the Council's legal advisors, although Amberside are willing to support with the drafting of HoT and other key documentation as the project progresses.

16 HEAT PRICING STRATEGY

At this stage of project development, the scheme has not been sufficiently developed to devise an effective heat pricing strategy. Once the outputs from the techno-economic model have been finalised and financial model development is in progression alongside the OBC, a heat pricing strategy will be devised.

The heat pricing strategy will be developed through engagement with proposed customers, aligning with HNDU's Whole Life Cost of Heat tool. Heat Trust guidelines and market expectations regarding pricing transparency and security of supply protections will be considered, as well as any potential changes to market regulations. Counterfactual energy prices will be calculated, justifying the variable, fixed, and connection charge portions for key customer groups. Lastly, after discussions with the Council, various scenarios will be run to show the impact of changes to the assumptions going forward.

As an interim solution for the techno-economic modelling, the heat pricing for E.ON's Loampit Vale scheme has been used as it is considered to be representative of a current market price for the area given the agreements for supply are established. At the next stage, this will be verified through a benchmarking process which will draw on Amberside's knowledge of the UK heat network market as well as consideration of the comparative cost versus the likely technical counterfactual. The indexation mechanism for the tariffs will also be carefully considered as this will materially impact the project economics and customers over the project life.

17 RISK ASSESSMENT

17.1 Techno-Economic Risks and Issues

The main technical and commercial risks and constraints for the implementation of the Lewisham Town Centre Heat Network have been considered and assessed. Key technical risks are shown in Table 31.

Risk ratings are the product of impact and likelihood. The impact measures how much of an affect the risk being realised would have, and the likelihood is a measure of how probable the risk realisation is. The score associated with current risk is the level of risk present if no further action is taken, and re-scored risk levels are a measure of the risk present once the mitigating measures have been carried out.

A key showing the level of risk is shown in Table 30.

Table 30: Risk level key

Impact	1	Insignificant
	2	Minor
	3	Moderate
	4	Major
	5	Catastrophic
Likelihood	1	Highly unlikely, but may occur in exceptional circumstances
	2	Not expected, but a slight possibility it may occur
	3	Might occur at some time
	4	There is a strong possibility of occurrence
	5	Very likely, expected to occur
Risk rating	0-5	**Low risk**
	6-14	**Medium risk**
	15-25	**High risk**

Table 31: Techno-economic risk register

	Risk / issue	Risk rating			Rationale	Mitigating measure / action
		Impact	Likelihood	Rating		
Energy demand	**ED1** Energy demands for some planned developments is based on information that may change.	Risk rating			Energy demands for some planned developments (such as Lewisham Retail Park and Shopping Centre Redevelopment) have been based on very high level information that is likely to change as development plans are progressed.	Energy demands for all planned developments have been estimated based on the most recent information available from developers. Energy demands should be re-assessed as development plans progress and if development plans change.
		3	4	12		
		Mitigated risk rating				
		3	3	9		
Energy demand	**ED2** Where actual data has not been received heat demands and profiles have been modelled	Risk rating			Building peak loads determine network pipe diameter requirements and heat demand profiles have a significant impact on technical and economic viability assessments of the proposed network.	The hourly, daily and annual heat demand of buildings have been modelled based on building use, occupancy / heating patterns and local temperature data. SEL has a database of hourly annual demand profiles for a wide range of building types, and these are used to provide estimated heat demand profiles for buildings where half hourly data has not been obtained.
		3	4	12		
		Mitigated risk rating				
		3	3	9		
Energy demand	**ED3** Potential heat connections do not connect / planned developments are not brought forward.	Risk rating			This can cause network demands to change from those assessed. Heat demand significantly impacts network viability. If key existing buildings do not connect, or key planned developments are either not built out or are built out but do not connect, then this will reduce the viability of network options. Volume risk is likely to sit with the network operator.	Engagement with key heat demand stakeholders has commenced, continued stakeholder engagement will be required as the project progresses. LBL should continue to work with developers to convey the benefits of network connection and ensure planning requirements continue to drive network development, futureproofing, and connection through GLA's heat hierarchy.
		4	4	16		
		Mitigated risk rating				
		4	3	12		
Energy demand	**ED4** Engagement with developers is not achieved and developments do not connect to network	Risk rating			If planned developments do not connect this would lead to a reduction in heat sales from the network. Key planned developments are the Shopping Centre redevelopment and Lewisham Retail Park which make up a large proportion of the network heat demand and contribute significantly to the project through connection charges.	Effective, continued engagement with developers is essential and the benefits of connecting new buildings to the network need to be made clear. Consideration has been given to enabling solutions that can supply heat to the earliest planned developments (2028) before the wider network is built out.
		2	3	6		
		Mitigated risk rating				
		2	2	4		

	Risk / issue	Risk rating			Rationale	Mitigating measure / action
		Impact	Likelihood	Rating		
Energy centre	**EC1** Not securing suitable energy centre locations.	Risk rating			The network is reliant on a suitable energy centre location being secured with ease of access to Riverside Data Centre. The preferred site (Molesworth Street Car Park) is planned to be used as a bus layover site by TfL during construction of the Bakerloo Line Extension, making it unavailable for use as an energy centre location. Limited suitable alternative sites have been identified.	The recommended location for the energy centre has been identified as the land north of Molesworth Street Car Park, which remains in close proximity to the data centre heat source and key heat loads. Further work is needed to safeguard this site as an energy centre location. Alternative sites have been assessed, as described in Section 5, and should continue to be explored, including the Shopping Centre redevelopment site and discussions with TfL about Molesworth Street Car Park.
		5	4	**20**		
		Mitigated risk rating				
		5	3	**15**		
	EC2 The energy centre is not brought forward in time.	Risk rating			If the energy centre is not brought forward in time to supply Shopping Centre redevelopment and Lewisham Retail Park with heat, developers will install individual ASHPs. This will significantly impact network economics and viability of the network.	Further work is needed to safeguard this site as an energy centre location. Alternative sites have been assessed, as described in Section 5, and should continue to be explored, including the Shopping Centre redevelopment site and discussions with TfL about Molesworth Street Car Park. Enabling solutions have been developed to provide an interim solution which can be implemented prior to the preferred energy centre location becoming available.
		5	4	**20**		
		Mitigated risk rating				
		5	3	**15**		
	EC3 Utility connections to the energy centre	Risk rating			The required utility connection could pose both technical and economic risks. The data centre has already secured significant electrical capacity in the area, but with planned developments also requiring capacity, there is an increased risk of limited availability. A decrease in available capacity in the area could significantly increase the costs of electrical connection due to grid reinforcement or changes in the point of connection requirements.	A budget quote for full electric backup scenario has been requested from UK Power Networks to ensure that the highest potential cost estimate is used in the economic assessment. Budget quote request does not reserve the electrical capacity or switch positions. A formal quote should be requested when the project progresses to the commercialisation stage to secure the necessary capacity for the energy centre.
		3	4	**12**		
		Mitigated risk rating				
		3	3	**9**		
	EC4 Energy centre design does not allow for connection	Risk rating			Consideration should be given to futureproofing to ensure the heat network could expand.	The current energy centre includes future proofing to allow for expansion to meet the Phase 1 & Phase 2 demands. The current energy centre site on the land north of Molesworth Street Car Park is too small to allow for future expansion.
		4	4	**16**		

	Risk / issue	Risk rating			Rationale	Mitigating measure / action
		Impact	Likelihood	Rating		
Energy centre	of potential future heat sources, meaning there is little futureproofing.	Mitigated risk rating				Potential additional space for the energy centre could be negotiated with TfL to utilise part of the Molesworth Street Car Park. TfL has been contacted to share their position on the possibility of co-using the car park.
		4	3	12		
Energy centre	**EC5** The visual and noise impact of the energy centre is deemed significant.	Risk rating			The visual impact of the building is unlikely to be significant. Should it be deemed significant, it may increase design costs or limit the energy centre size. The visual and noise impact of the air heat exchangers (included for resilience) may be an issue with regards to planning permission	The proposed energy centre is located near a very busy road with no sensitive noise receptors nearby. If required, the energy centre can be designed to included acoustic attenuation on building fabric and ventilation to minimise noise output. The visual impact and other requirements, such as reinstating drainage, should be further assessed and discussed with LBL as the project progresses. The building materials will be selected to harmonise with the local vernacular. The thermal store has been sized to blend cohesively with the energy centre building, minimizing visual impact. However, the visual impact of the heat exchangers on the roof (to enable ASHP back-up supply) may be more significant, depending on the height and proximity of surrounding buildings. A screen may be required around the air heat exchangers to minimise visual and noise impact.
		4	3	12		
		Mitigated risk rating				
		4	2	8		
Energy centre	**EC6** Availability of heat from data centre.	Risk rating			Based on the data centre's operation, the heat availability has been assumed to be year-round. If heat from the data centre becomes unavailable, the heat demand will need to be met by other heat sources, which will impact the heat pump SPF and, consequently, the operational costs.	The peak and reserve electric boilers could supply heat demand if data centre heat becomes unavailable. However, this would significantly impact the scheme economics. The energy centre could switch to air heat exchangers when data centre heat offtake is unavailable, improving resilience and ensuring that heat can be provided via heat pumps, which are more efficient than electric boilers.
		4	4	16		
		Mitigated risk rating				
		4	2	8		
Network	**N1** Network options presented do not allow connection of additional heat demands.	Risk rating			Network options should, where possible, include futureproofing to allow additional heat demands to connect in the future, otherwise long-term success of the network may be damaged. Consideration should therefore be given to futureproofing to ensure the network has the	Careful consideration has been given to futureproofing the network, ensuring it can accommodate Phase 2 demands, potential expansion opportunities, and efficient short- and medium-term operations. Valves are strategically planned for installation at potential extension points.
		4	4	16		

	Risk / issue	Risk rating			Rationale	Mitigating measure / action
		Impact	Likelihood	Rating		
Network		Mitigated risk rating			capacity to serve future network phases and planned developments.	As the project progresses, it will be essential to continuously monitor development demands.
		4	2	8		
Network	**N3** Network construction difficulties.	Risk rating			Unforeseen difficulties encountered during network construction increase CAPEX and impacts on the project programme.	The main physical barriers, issues and constraints within the study area have been considered and, where possible, avoided during the network prioritisation process. C2 surveys, GIS layers and utility maps have been reviewed. These constraints should be further investigated during the commercialisation phase, such as through ground-penetrating radar surveys.
		4	4	16		
		Mitigated risk rating				
		4	3	12		
Network	**N4** Existing buildings are not district heat ready.	Risk rating			High return temperatures can significantly impact on the performance of networks, particularly for networks served by heat pumps. Heating system upgrades may be required for existing buildings, to ensure lower network return temperatures. Increase peak boilers usage leading to an increase in OPEX and CO_2 emissions.	This has been taken into account when sizing heat generation. Secondary side upgrades included within CAPEX.
		4	4	16		
		Mitigated risk rating				
		4	2	8		
Economic assessment	**EA1** Capital costs are significantly higher than estimated.	Risk rating			Higher capital costs can have a significant impact on the viability of all network phases. If the economic assessment does not include robust project CAPEX, the likely financial benefits or does not provide sufficient information to secure funding, then the network plan will not progress.	All project costs have been based on a combination of previous project experience and recent quotes for similar projects. The consultant team have a large database of actual costs of installing district energy schemes including costs for equipment supply and installation, distribution pipework supply and installation, trench excavation and re-instatement. Sensitivity analysis has been undertaken for network options to show the effect of a variance in capital costs, shown in section 10.3. Risk contingency has been applied to all CAPEX items.
		5	4	20		
		Mitigated risk rating				
		5	2	10		
Economic assessment	**EA2** Variation in heat sales tariffs significantly affects economics.	Risk rating			A variation in the heat sales tariffs has a significant impact on the viability of all network options.	Heat sales tariffs have been based on the cost of the low carbon counterfactual i.e. local heat network. Sensitivity analysis has been undertaken to show the effect of heat sale tariff variation, shown in section 0.
		5	3	15		
		Mitigated risk rating				
		5	2	10		
Economic assessment	**EA3**	Risk rating				
		5	4	20		

	Risk / issue	Risk rating			Rationale	Mitigating measure / action
		Impact	Likelihood	Rating		
	Variation in electricity import tariffs significantly affects economic viability.	Mitigated risk rating			Variation in electricity import tariffs have a significant impact on the viability of network options.	Import tariffs have been based on DESNZ price projections for the network start year (2028). Sensitivity analysis has been undertaken to show the effect of electricity import tariff variation, shown in section 0.
		5	3	15		
General	**G1** The project is not progressed	Risk rating			As there is minimal public sector heat demand within the assessment area the preferred option is for private sector to develop the scheme. If the private sector is not engaged/ aware of the study findings the project might not be developed.	The key stakeholder and potential private sector investors have been engaged throughout the project. It is recommended that the technical and commercial work in this study is appropriately shared to provide evidence in the engagement with key stakeholders and potential investors.
		5	4	20		
		Mitigated risk rating				
		5	3	15		
	G2 Planned developments are brought forward prior to network development.	Risk rating			Developers may install alternative low carbon heating systems within planned developments if DHNs are not in place prior to construction.	The timing of planned developments has been estimated at a high level. Further discussions with LBL Planning teams and developers will be required as the project progresses to establish development timescales and to ensure the network is available for a day 1 connection.
		4	4	16		
		Mitigated risk rating				
		4	3	12		
	G3 Liaison between departments within LBL is critical for network development.	Risk rating			Engagement with departments within LBL, (including Highways, Property, Planning, Regen, etc.) is critical for network development to ensure energy centre locations and network routes are secured and safeguarded, to inform network design and to enable coordination of works.	Initial discussions have been undertaken with LBL regarding energy centre locations and planned development details. Ongoing engagement is critical as the project progresses, especially around energy centre location and securing the land. The results of this study should be fed back in further engagement.
		5	3	15		
		Mitigated risk rating				
		5	2	10		
	G4 The Local Authority Planning team is not fully engaged / aware of the study outputs	Risk rating			Planning officers have a key role to play in ensuring the viability of the project. The role of planners in DH is to provide appropriate policy and supporting guidance to developers in the development or extension of networks.	Engagement with planning officers has taken place and will be ongoing as the project progresses. It is recommended that the technical and commercial work in this study is appropriately shared to provide evidence in the engagement with planners.
		4	2	8		
		Mitigated risk rating				
		4	1	4		

17.2 Key Commercial Risks and Opportunities

The specific key risks to the scheme that have been discussed in previous sections are summarised as follows:

Existing ESCos –The presence of existing 'island' networks (e.g. E.ON's Loampit Vale scheme) whilst presenting an opportunity, may also present some 'incumbency' challenges (pre and post Heat Network Zoning). For example, if Lewisham Council selected a third-party ESCo that is not E.ON, then an agreement between the third-party ESCo and E.ON might be required to make the wider scheme viable, which could potentially be commercially challenging.

Molesworth Street Car Park – Transport for London (TfL) holds a material restriction on Molesworth Street Car Park which specifies that no transfer of interest is to be registered without the consent of The London Development Agency, TfL and London Bus Services Limited. To date, our communication with TfL and parties familiar with the matter have revealed that TfL are likely to forcefully object to the development of an energy centre on Molesworth Street Car Park.

Landsec development programme – The redevelopment of the shopping centre site is highly material in terms of energy loads and could also impact Planning in relation to energy centre location and transport planning. Active collaboration (and Council's influencing mechanisms) will therefore be key to ensure that a heat network represents an attractive offering that aligns to Landsec's development programme (as they cannot have any utility uncertainty due to the scale of their real estate investment).

General / market attractiveness – Heat networks remain by nature a relatively immature asset class in the UK, even though they have recently gained significant traction from policy support and increasing investor interest. Typical risks include build-out delays and lack of demand assurance, and macroeconomic factors including cost inflation, energy price volatility, and interest rates. Lewisham town centre does have an advantage in terms of existing heat density, London land values, and the real estate development activity, combined with positive local policy support.

18 CONCLUSIONS

There is a significant opportunity for a heat network in Lewisham Town Centre which would exploit the heat demands of planned new developments, potential for heat supply to existing heat networks in the area and recovery of waste heat from the Riverdale Data Centre. However engagement with the key project stakeholders identified that the main project risk is whether the timing of the network build out could align with key stakeholder milestones and construction timeframes. For example, if the heat network is not developed in time to supply heat to planned new developments (Landsec Shopping Centre Redevelopment and the Retail Park Development in 2028) then they will likely be built with individual low carbon heat solutions instead (such as ASHP), and so may only connect to the network when the ASHPs reach end of useful life (after circa 15 years). Existing buildings may also need to progress the retrofit of individual low carbon heat solutions to meet their net zero targets if a network solution is not available within the timescale required.

Also, it should be noted that the three existing heat networks in the area (Loampit Vale, Gateway 1 and 2) are currently supplied with heat via gas fired CHP plant. These networks are planned to decarbonise by 2030-2032 to align with the operators' decarbonisation targets and end of useful life of CHP plant and so this is a critical timeline for further network development.

Preferred Solution (Option A)

A range of heat technology options were assessed, but a heat network utilising waste heat offtake from Riverdale Data Centre will offer the highest heat source temperatures. This will result in the highest heat pump efficiency and potentially the lowest heat sale tariffs and lowest carbon intensity, offering the best performance against the key CSFs. Waste heat offtake from Riverdale Data Centre also has the potential to supply a wider town centre area; circa 5 MW of low-grade heat could be diverted from the data centre cooling towers, and in the future, the rooftop air chillers could provide additional heat offtake capacity. This solution also includes external air heat exchangers to allow the heat pumps to operate as air source heat pumps as a redundancy measure if heat from the data centre is offline for any reason. Therefore heat pumps with the heat source of waste heat offtake from Riverdale Data Centre is taken forward as the preferred option.

The fully built out network includes:

- The Landsec Shopping Centre Redevelopment,
- Provision of low carbon heat to the main E.ON network, including Prendergast Vale School connection
- The Retail Park Development which would be supplied via the existing E.ON. heat network through a sleeving arrangement
- Gateway 1 & 2 (offsetting heat supplied by the existing CHP plants)

The economics for the preferred network solution are shown below.

Solution A - Summary of key metrics and technology	
	Fully built out network
Total heat demand (excl. losses), kWh	26,591,738
Network trench length, m	551
Network linear heat density, MWh/m	48.2
Network peak demand (incl. losses), kW	8,044
Energy centre size, m^2	348
Thermal stores, litres	120,000
WSHP capacity, kW	4,000
Air heat exchangers (for redundancy), kW	2,000

Solution A - Summary of key metrics and technology	
	Fully built out network
Electric peak and reserve boiler capacity, kW	7,000
% heat demand met by low carbon / renewable technology	92%
Estimated phase start year	2030

Economic and Carbon Summary

The economic and carbon summary for the full Lewisham Town Centre Heat Network (initial and later phases combined) is shown below with and without grant funding at 35%, as well as commercialisation funding only:

Summary of preferred solution (A) economics, CO_2e emissions and intensity				
		Without grant funding	With commercialisation funding only	With 35% grant funding
Total capital costs (including contingency)		£15,668,166		
Total connection charge		£8,227,500		
Total grant funding			£673,150	£5,358,056
25 years	IRR	8.1%	9.1%	24.8%
	NPV (3.5% discount rate)	£4,871,370	£5,544,520	£10,229,426
	Simple payback	11 years	10 years	5 years
	Net income	£11,953,720	£12,626,870	£17,311,776
	Network CO_2e emissions	7,587 tCO_2e		
40 years	IRR	8.7%	9.6%	23.9%
	NPV (3.5% discount rate)	£8,170,397	£8,843,547	£13,528,454
	Simple payback	12 years	11 years	5 years
	Net income	£23,041,347	£23,714,497	£28,399,404
	Network CO_2e emissions	8,878 tCO_2e		
First year CO_2e intensity of heat delivered		53 g/kWh		

Key assumptions:

- Variable heat tariff 9.01 p/kWh
- Fixed heat sale tariffs £14.64/kW of connection capacity/day
- Year 1 (2028) energy centre electricity tariffs of 12.7 p/kWh
- Connection charges based on avoided costs of ASHP installation at £750/kW
- CAPEX includes contingency

Energy Centre Constraints

The key constraint to developing a heat network aligned with stakeholder timeframes and milestones is the securing of a suitable location for the energy centre. The shortlisted options identified are:

- **Molesworth Street Car Park**: This location is adjacent to the preferred heat source (data centre waste heat offtake) and has buildable land circa 1,500 m². However, if the planned Bakerloo Line Extension (BLE) goes ahead, TfL will be required to relocate its 18 bus bays (currently located at Thruston Road), during the BLE construction period of circa 8 years. TfL has identified the Molesworth Street Car Park as the preferred location for relocating the bus stands during the construction of the BLE. The site has a restriction within the title register stating that no disposition is to be registered without the consent of The London Development Agency, TfL and the London Bus Services Limited. Further discussions/negotiations are needed with TfL to confirm if the BLE extension and bus stands relocation is going ahead and if so to understand whether a compromise can be reached over the use of the land (which may include a possible joint use of the space, or use of part of the space to accommodate a network energy centre).

- **Land North of Molesworth Street Car Park**: This location is adjacent to the preferred heat source (data centre waste heat offtake) and has buildable land of circa 400 m². This land is Council-owned but would require the removal of several trees and further engagement with LBL for planning & biodiversity implications. Discussions/negotiations with TfL would still be required for the installation of network pipework across the adjacent car park to connect the data centre to the energy centre.
- **Shopping Centre Redevelopment**: It is proposed that an energy centre could be implemented as part of the new Shopping Centre Redevelopment, or located within a new dedicated energy centre building on site which would require negotiations with the developer. This location is not preferred by the Shopping Centre developer and is further away from the preferred heat source which may cause technical complexity.

The preferred location is the Molesworth Street Car Park as it has closest proximity to the data centre heat offtake and a large buildable area. However, if the BLE goes ahead then this may mean that the car park and the adjacent land to the north of the car park are impacted and may not be available, or if a compromise can be reached on the land use, it is not likely to happen in time for an energy centre to be built to meet the heat on date of the Landsec Shopping Centre Redevelopment and Retail Park Development (2028). Therefore, interim/enabling solution have been identified.

Interim Enabling Solution (Option B)

If there are delays to developing an energy centre at Molesworth Street Car Park or on land adjacent to the car park, an interim solution could be to install heat pump plant above the existing data centre CCHP energy centre. An additional floor could be added, or the space within the existing CCHP energy centre could be repurposed following the removal of the existing CCHP plant (current building footprint is circa 250 m²). The smaller footprint would result in a reduced heat pump capacity being installed to utilise waste heat from the data centre, but it would be sufficient to supply the Landsec Shopping Centre Redevelopment, and the Retail Park Development which require heat by 2028. It is proposed that the full energy centre would then be built out at Molesworth Street Car Park and/or land to the north of the car park when it come available. This solution was identified as potentially attractive/investable by SDCL, the data centre energy centre owner.

The Council should continue engagement with TfL with regards to the use of the Molesworth Street Car Park and adjacent land and if it becomes clear that there will be delays/barriers to the use of the land which will prevent the Initial Phase connections i.e. Shopping Centre Redevelopment and Lewisham Retail Park Development, being supplied by 2028, then the enabling solution should be progressed.

Delivery Strategy and Funding Options

There are two key factors that are motivating the Council with regards to their selection of delivery approach:

Council Capacity – There is limited capacity in the Council to sponsor a heat network scheme i.e. the Council does not have enough resource (both in terms of finance and person-hours) available to deliver a heat network.

Privately Owned Heat Loads – There are a very limited number of nearby Council-owned / public sector buildings to connect to the heat network. The main heat loads are either privately owned communal / small-scale heat networks or large private developments.

The Council also confirmed that its priority is for construction and operation of the heat network to occur as soon as possible, and hence would prefer to cede control of the scheme to a third-party sponsor / developer to ensure the scheme is delivered.

Through discussions with the Council to date, it was found that a private sector led delivery / 'Energy as a Service' model is most suitable for the Lewisham Town Centre Heat Network. This is primarily because there is limited capacity in the Council to sponsor the scheme and most heat loads are privately owned.

Until thorough soft market testing has been undertaken and a business case developed, Lewisham Council's role should remain under discussion. The presence of existing 'island' networks (e.g. E.ON's Loampit Vale scheme) whilst presenting an opportunity, may also present some 'incumbency' challenges. For example, if Lewisham Council selected a third-party ESCo that is not E.ON, then an agreement between the third-party ESCo and E.ON might be required to make the wider scheme viable, which could potentially be commercially challenging. There may also be potential impacts of the forthcoming Heat Network Zoning regulations and an incoming Zone Coordinator for Lewisham with the power to determine the zone delivery model, facilitate the procurement process and enforce local zoning requirements is anticipated.

If the project progresses to the next DPD stage, a detailed preferred funding strategy should be developed.

Next Steps

The Council's ultimate goal is to decarbonise the town centre, with affordable tariffs, and the development of a district heating network is the optimal solution to achieve this.

To formulate a meaningful strategy for the Council to take forward, we have assumed the following key points based on discussions with the Council:

- The Council is not going to provide any capital investment to the project
- The Council does not want to create a formal JV
- The Council would not be a major customer to the heat network, as there are no Council-owned buildings being proposed to connect
- The Council's major role is to enable the development of the network

Therefore it is recommended that the Council facilitates a market selection exercise for the energy centre land (Molesworth Street Car Park and/or land to the north of the car park) which will then ultimately facilitate an investor to develop the network. The Council will need to embark on work around land identification which will include technical, legal and title due diligence to make the opportunity appealing to the market. Dependent on the Council's priorities, reaching this point can be achieved in either a more or less developed way:

- Minimum Developed Entry – Given that the Council's role is likely to be light touch, the energy centre land could be marketed on the basis of the work done to date, leaving it to the bidders to ultimately "solve" the issues highlighted in this report
- Maximum Developed Entry – The Council could undertake more-in house development of the project, including a reference design and a financial model to be utilised for soft market testing with the private sector and as an appraisal tool for the selection process.

With regards to funding, it is recommended that the Council applies for commercialisation funding under the next round of GHNF to pay for the necessary advisor costs to facilitate the market selection exercise. Zero Carbon Accelerator and Heat Network Delivery Unit can also provide funding for advisor costs and should be explored as an immediate action. A construction grant application should also be considered (GHNF or otherwise) to increase the attractiveness of the project to the market.

APPENDIX 1: BOREHOLE ASSESSMENT

Table 32 lists the borehole records in and around Lewisham Town Centre, which have a depth of at least 30 m and are within close proximity to the potential energy centre locations or have a sufficient flowrate for consideration.

Table 32: Borehole records data

Borehole name	Approximate distance from E.ON energy centre, km	Depth, m	Water depth, m	Flowrate, l/s	Strata Details	Date
TQ37NE130 - Loampit Vale Lewisham	0.2	38.10	Unknown	5.05	0-6.7m; Existing dug well 6.7-38.1m; Chalk and flint	1907
TQ37NE818 – White Lane Laundry Blackheath Hill	0.9	106.68	30.02	13.16	0-11.58m; Made ground 11.58-16.15m; Brown clay and pebbles 16.15-17.07m; Grey sand and flints 17.07-21.64m; White sand 21.64-106.68m; Chalk and flints	1931
TQ37SE678 – Beacon Road Hither Green	1.6	121.92	6.22	18.94	0-12.192m; London Clay 12-28.956m; Woolwich and Reading Beds 28.956 – 44.196m; Thanet sands 44.196-112.166m; Upper chalk 112.196-121.92; Middle chalk	1968
TQ37NE1902 – Turnham Road Brockley	1.8	179.83	28.12	18.94	0-11.58m; London clay 11.58-31.09m; Woolwich + Reading Beds 31.09-42.67m; Thanet sands 42.67-111.25m; Upper chalk 111.25-179.83; Middle chalk	1967
TQ37SE88/A – Gasworks At Bell Green Lewisham	3.9	121.92	10.97	39.40	0-3.048m; Made ground 3.048-28.956m; Clay and stones 28.956-39.624m; Pebbles, sand and clay 39.624-42.672m; Black clay, hard stone and pebbles 42.672-58.826m; Hard sand 58.826-121.92m; Chalk and flints	1931

APPENDIX 2: TECHNOLOGY SIZING

Energy generation technologies are assessed using in house software that has been developed to allow detailed sizing of plant and thermal storage, modelling of operating parameters and conditions, financial assessment, and sensitivity analysis. The software utilises hourly network demands for each day of the year and considers hourly energy outputs from low carbon technologies, thermal storage and peak and reserve plant considering modulation limits, efficiencies and plant down time for maintenance. A range of plant and thermal store sizes and number of units are assessed and optimised to ensure key operating, and financial/investment criteria are met.

The tools consider:

- Heat demand that can be served by the plant
- Thermal storage – used to supply heat loads below modulation limits or peaks above plant capacity and minimise plant firing e.g. for heat pump, store size will be modelled, optimised and cost/benefit analysis conducted to consider the optimum operating strategy for heat generation
- Supply strategy – consideration of issues such as varying seasonal or diurnal operation, continuous operation, modulated or full output, primary energy source or base load only and peak and reserve plant requirement
- Peak and reserve boiler sizing – according to the diversified peak demand of the various network phases, predicted operating requirements and redundancy
- Peak supply and minimum load – this will consider plant modulation limits and the number of units
- Carbon savings – these will be calculated against the 'business as usual' case and include annual and lifetime savings based on the most up to date DESNZ carbon emissions projections

Where heat pumps have been included, these have been sized based on network heat demand and have been maximised to provide the greatest economic and CO_2e savings for the network option and to provide the optimum balance between heat generation capacity, capital cost, maintenance costs and physical size.

The heat pumps and thermal stores have been sized with consideration of the hourly annual network heat demand. Peak and reserve boilers will meet any remaining demand. Technology sizing is based on an iterative process within the technical model to identify the optimal balance of the priorities.

Figure 70 shows the output from the SEL technology sizing tool for the Phase 2 network served by 3.5 MW heat pumps.

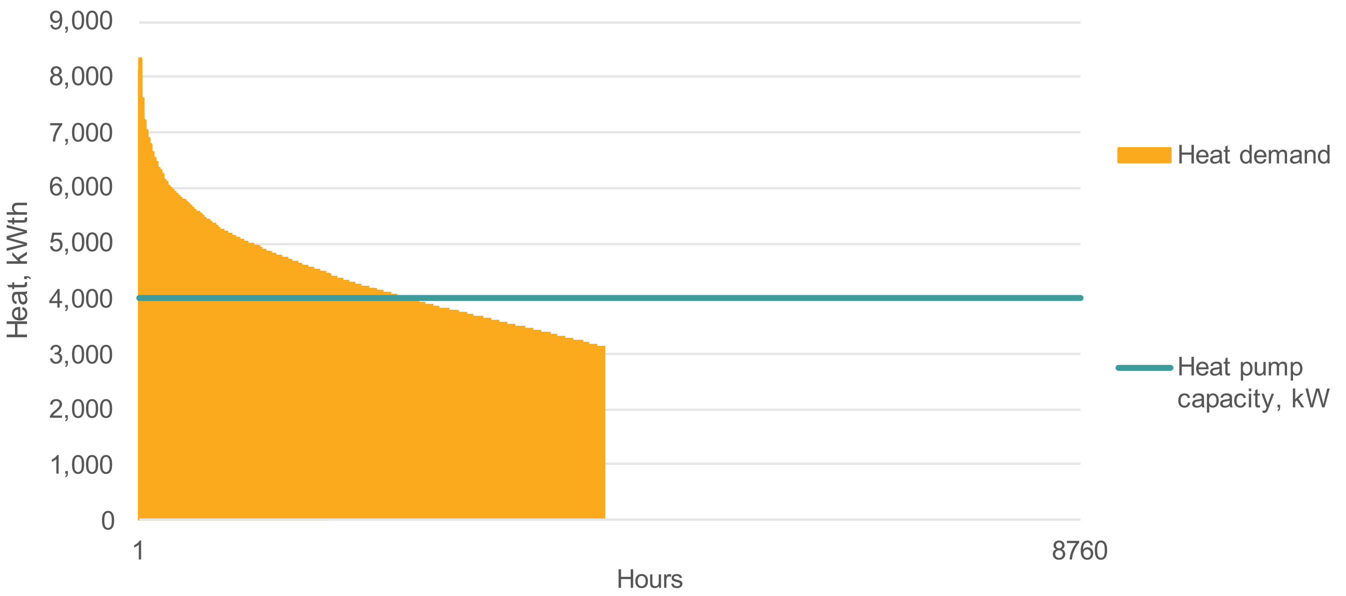

Figure 70: Phase 2 load duration curve

The load duration curve shows the heat demand for every hour of a year, ordered from highest to lowest. The turquoise line shows the total low carbon and renewable capacity installed in the energy centre. The heat demand above the grey line is met by thermal storage and peak and reserve boilers.

Figure 71 shows the proportion of the heat demand supplied by the heat pump, charge and depletion of the thermal store and heat demand supplied by peak and reserve boilers for Phase 1 and Phase 2 of the network from 1st and 2nd Jan. The heat pump and thermal stores meet the majority of the baseload heat demand with a small proportion of the demand met by peak and reserve boilers. When possible, the thermal store is charged when the heat demand of the network is lower than the heat pump capacity, as shown in Figure 71.

Thermal stores have been sized based on hourly network heat demand, heat pump capacities, modulation limits and capital costs. The thermal store provides significant benefits at times of peak network demand and when heat generation is restricted by modulation limits.

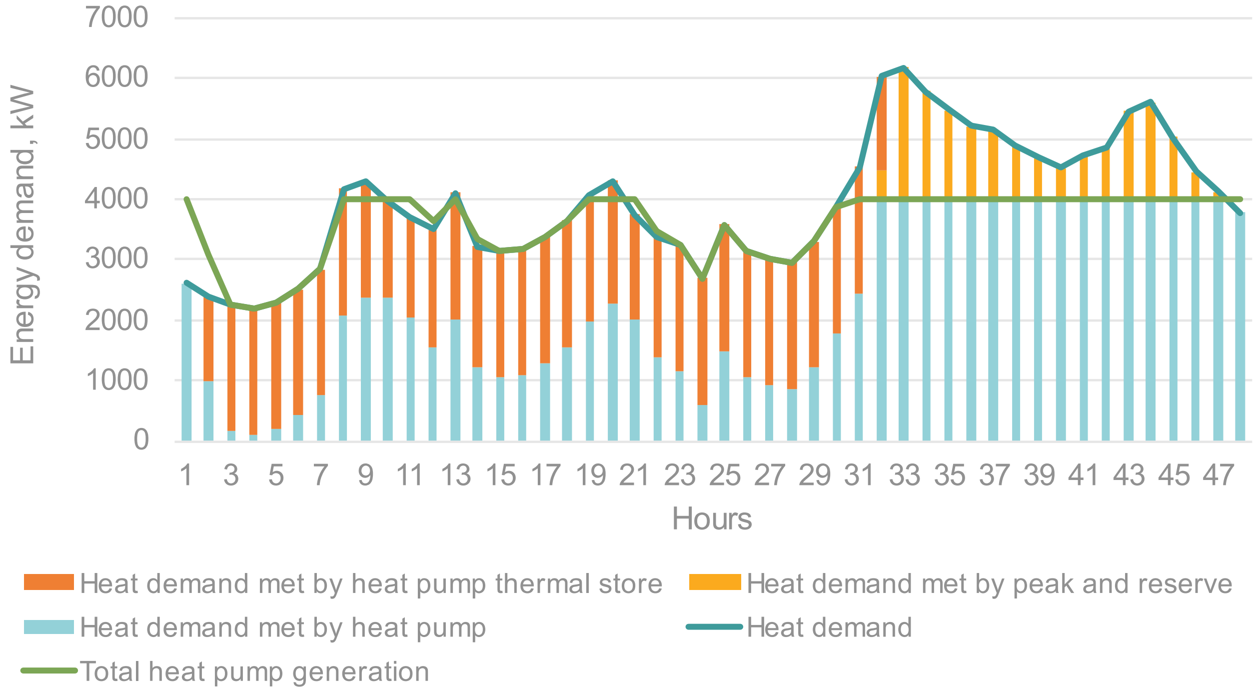

Figure 71: Heat generation 1st and 2nd Jan – full network

APPENDIX 3: NETWORK CONSTRAINTS

APPENDIX 4: KEY PARAMETERS AND ASSUMPTIONS

Energy Centre Tariffs

The energy tariff (without CCL) used in the techno-economic modelling assessment is shown in Table 33. The energy tariff used for the assessment is the commercial energy tariff figure from the 2023 DESNZ energy price projection for the year 2028 (Phase 1 starting year). A CCL rate of 0.775 p/kWh will be applied for both gas and electricity tariffs.

Table 33: Energy centre import tariff

Scenario	Gas unit rate, p/kWh	Gas standing charge, £/day	Electricity tariff, p/kWh
Lewisham Town Centre network	3.20	30	12.70

Key Technology Parameters

Key technology parameters for the network are shown in Table 34.

Table 34: Technical inputs

Parameter	Value	Source of data / assumption
SPF_{H1} for heat pump	4.53	Varies for each network phase derived from manufacturers' performance curves based on the selected heat pump, assumed water conditions for the site and required network temperatures.
Peak and reserve boiler efficiency	99% electric	Expected efficiency of new electric boilers based on the experience of the operating plant.

Technology replacement costs have been calculated on an annualised basis and take into account the expected lifetime of the technology, fractional repairs and the length of the business term. Plant/equipment lifetimes are shown in Table 35.

Table 35: Plant and equipment lifetime

Plant/equipment	Lifetime	Fractional repairs
Heat pumps	20 years	50%
Peak and reserve boilers	30 years	100%
Heat network customer - building connections	20 years	100%

Table 36: Energy centre building costs

Energy Centre, m^2	Cost, £/m^2
348	4000

Heat Taken Out of Heat Source

Heat required from data centre to supply heat demand - methodology

The formulas that are used to calculate the heat extraction required to meet the network's peak heat demand are shown below.

Equation for Coefficient of Performance (1):

$$COP = \frac{Heat\ out}{Electricity\ in} = \frac{Q_H}{E_{in}}$$

Equation (1) rearranged to make E_{in} the subject (2):

$$E_{in} = \frac{Q_H}{COP}$$

Equation for heat going to network (3):

$$Q_H = Q_L + E_{in}$$

Equation for heat required from heat source (4):

$$Q_L = Q_H - E_{in}$$

Equation (2) substituted into equation (4):

$$Q_L = Q_H - \frac{Q_H}{COP}$$

Where:

Q_H – Heat from heat pump going network

Q_L – Heat from heat source

E_{in} – Electricity put in to compress refrigerant

COP – Coefficient of Performance

DESNZ Energy Price Projections

The DESNZ fossil fuel price projections (central scenario) are shown in Table 37.

Table 37: DESNZ fossil fuel price projections

	Sector	Units	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Electricity	Industrial	p/kWh	20.9	11.9	11.3	11.2	10.9	11.1	11.1	11.2	11.1	11.2	11.6	11.7	11.7	11.7
	Residential	p/kWh	40.3	34.8	22.3	21.3	20.8	20.7	20.6	19.8	19.8	20.1	20.4	20.2	20.2	19.6
	Services	p/kWh	23.0	13.8	13.2	13.0	12.7	12.8	12.7	12.7	12.6	12.6	13.0	13.1	13.1	12.9
Natural gas	Industrial	p/kWh	5.6	2.5	2.2	2.3	2.3	2.3	2.4	2.4	2.5	2.5	2.5	2.6	2.6	2.6
	Residential	p/kWh	11.3	8.6	5.2	4.9	4.9	4.9	4.9	5.0	5.0	5.0	5.0	5.1	5.1	5.1
	Services	p/kWh	6.4	3.3	3.0	3.1	3.1	3.2	3.2	3.2	3.3	3.3	3.3	3.4	3.4	3.4

CO_2e Emissions Factors

The electricity grid CO_2e emissions figures used in assessments are shown in Table 38.

Table 38: Electricity grid CO_2e emissions

Year	Electricity grid CO_2e emissions, gCO_2e/kWh			Year	Electricity grid CO_2e emissions, gCO_2e/kWh		
	LCP marginal	IAG marginal (commercial)	DEFRA average		LCP marginal	IAG marginal (commercial)	DEFRA average
2023	382.8	250.4	255.0	2037	250.0	28.9	29.4
2024	381.1	235.6	240.0	2038	248.9	23.4	23.8
2025	381.2	219.9	224.0	2039	249.5	18.9	19.3
2026	382.0	203.4	207.2	2040	243.4	15.3	15.6
2027	367.9	185.9	189.4	2041	239.3	12.7	12.9
2028	359.2	167.4	170.6	2042	249.0	12.1	12.3
2029	333.8	147.9	150.7	2043	246.9	11.8	12.0
2030	311.9	127.3	129.7	2044	228.7	11.1	11.3
2031	316.1	103.0	104.9	2045	228.7	9.4	9.6

Year	Electricity grid CO_2e emissions, gCO_2e/kWh			Year	Electricity grid CO_2e emissions, gCO_2e/kWh		
	LCP marginal	IAG marginal (commercial)	DEFRA average		LCP marginal	IAG marginal (commercial)	DEFRA average
2032	293.0	83.3	84.9	2046	228.7	8.6	8.7
2033	279.5	67.4	68.7	2047	228.7	7.9	8.0
2034	260.0	54.6	55.6	2048	228.7	7.5	7.6
2035	248.3	44.1	45.0	2049	228.7	7.0	7.1
2036	263.8	35.7	36.4	2050	228.7	6.9	7.0

Table 39: Natural gas CO_2e emissions

Parameter	Value
Natural gas CO_2e emissions factor, gCO_2e/kWh	183.9
Average efficiency for BAU gas boilers	90%

CAPEX

Capital costs for the scheme are based on a combination of previous project experience, quotations for recent similar works and soft market testing. Soft market testing has been conducted with potential suppliers of plant and equipment.

A summary of network capital costs for the Lewisham Town Centre network is shown in Table 40.

Table 40: Capital costs – Lewisham Town Centre Network – Solution A

	Contingency	CAPEX including contingency	
		Phase 1	Phase 2
Commercialisation costs (e.g. professional fees, legal, design, surveys, etc.)	10%	£471,582	£201,567
Contractor costs for preliminaries, project management and design	10%	£754,532	£322,508
Cost of land purchase/lost land value	10%	£0	£0
Energy centre building	15%	£1,600,800	£0
Heat pump	10%	£1,320,000	£1,320,000
Cost of accessing the heat source (heat exchangers for offtake)	15%	£287,500	£287,500
Heat pump M&E	20%	£435,000	£435,000
Peak and reserve electric boilers	10%	£137,500	£247,500
Pressurisation	10%	£23,356	£63,050
Water treatment	10%	£15,146	£40,886
Main district heat network pumps	10%	£26,977	£72,823
Controls	20%	£192,000	£60,000
Other energy centre M&E	10%	£378,979	£479,259
Thermal store(s)	10%	£264,000	£0
Data centre offtake connections	10%	£220,000	£0
Electricity grid connection	10%	£2,640,000	£0
Heat network spine (pipe and trench costs)	20%	£1,776,506	£788,731
Cost of connections at heat user locations	20%	£248,911	£388,445
Commissioning, testing & handover	10%	£168,108	£0
Total		**£10,960,897**	**£4,707,269**

The trench lengths and pipework costs for the two town centre phases can be seen in Table 41.

Table 41: Pipe schedule and indicative network costs

Size	Total trench length, m		Indicative pipework costs (including civils, and prelims, excluding contingency)	
	Phase 1	Phase 2	Phase 1	Phase 2
DN150	225.5	-	£642,854	-
DN200	186	139.8	£837,567	£657,276
Total	411.5	139.8	£1,480,421	£657,276

APPENDIX 5: TEMPLATE HEADS OF TERMS

Connection & Adoption Agreement

WARNING: This document is intended only to serve as a prompt to discussion of some of the key issues likely to arise in the context of the subject matter of this document. Substantive commercial and legal consideration will need to be given to a heat network scheme in order to develop the principles flagged below and others relevant to that particular scheme, and before the parties commit, in principle, to a set of "heads of terms" or develop and enter into a fully binding legal agreement. This document is no substitute for taking proper legal advice from lawyers experienced in district heating.

Connection & Adoption Agreement: *[ESCO]* (1) and *[Developer]* (2)	
Assumptions	• The Local Authority: ○ is either the Developer/ Landlord of a particular block in a development to be connected to the DHS and served with heat; ○ or has directly procured the delivery of the DHS and wishes oversight of the connection agreement entered into by e.g. the DBOM Contractor. • Secondary Network has been constructed by the Developer within the block being served by heat. • The Connection & Adoption Agreement will cover the physical connection of the DHS to a block requiring heat supply and the adoption of internal Secondary Network assets. • A "Framework Supply Agreement" may be entered into on or about the date of the Connection & Adoption Agreement, dealing primarily with (i) supply to the Development of heat prior to entry into Customer Supply Agreement by customers in domestic or commercial Units; (ii) risk in void periods; and (iii) governance of the terms on which heat is supplied to Customers. • Note that in some cases a combined Connection/ Adoption/ Framework Supply Agreement may be developed. Where the parties to the agreement are the same and are intended to be the same for the life of the Agreements, this may be a more suitable option.
Parties	(1) *[ESCO]* (2) *[Developer]*
Recitals	(A) *[Background to Project]* (B) *[Role of Party (1)]* (C) *[Role of Party (2)]*

	(D) *[Intention and role of this Agreement in context of Project]*
Representations and Warranties	*[Standard representations and warranties including:* • incorporation • powers • enforceability of obligations • conflicts with law/ other obligations • authorisations in place • no claims or litigation • no disposal or rights or assets used in connection with the Agreement without notification]
Term	• [Conditions Precedent] • Term
ESCO Obligations	***[Note: this list is non-exhaustive and general]*** **Connection & Adoption** • [Ensure that a connection of the required heat capacity is provided at the point of connection for the Development, by the relevant date of connection, in accordance with relevant technical specifications] • [Adopt the Secondary Network (and other relevant ancillary equipment)] **District Heating Scheme** • *[Ensure that design of the DHS is such that it can deliver heat to the capacity set out in the Connection & Adoption Agreement and has required flow temperatures at the Point of Connection]* • *[Provide heat to Customers under Customer Supply Agreements]* • *[Ensure that the DHS is designed, installed, operated and maintained so as to not cause damage to the Development]* **Provision of Operation and Maintenance Services** • [Ensure that operation and maintenance services are provided in relation to the Connection, from the date of connection, in order to enable the supply of heat to required standards] • [Ensure that operation and maintenance services are provided in relation to the Secondary Network, from the date of Adoption, in order to enable the supply of heat to required standards]

Developer Obligations	***[Note: this list is non-exhaustive and general]*** *[Install Secondary Network in accordance with relevant specifications]* *[Where the Developer maintains ownership of certain equipment, e.g. meters or HIUs within customer dwellings, the Developer may be under an obligation to ensure that such equipment is operated and maintained in a manner not to adversely affect the DHS]* *[Where part of the DHS continuity of supply solution, provide suitable spaces for housing temporary boilers]* *[Undertake not to install or permit the installation of other forms of heat generation (including gas) or connect to another district heating scheme]*
Ownership	*[Include relevant description of ownership structure of DHS within the block]*
Access	*[Appropriate property rights will need granted to the ESCO:* • [Provide]/[procure] licences/ easements/ title to assets to the ESCO in respect of use of and access where relevant during works to complete Connection] • [ESCO right to access without notice in an Emergency] *[Site rules should be provided to and followed by the ESCO]* *[Developer to grant a [non-exclusive] licence to exercise permissions:* • right to free, safe and uninterrupted access to the DHS within the Development: o to maintain, read, repair (etc) the DHS; o at any time in the case of an Emergency; o for any purposes required by a relevant law; o at all reasonable times to enable the ESCO to comply with its obligations under the Agreement] • right to install and retain equipment following variations.] *[In return for the benefit of the licence, the ESCO covenants with the Developer that it shall:* • ensure the DHS is kept in good repair; • comply with all Laws; • not do anything that renders the Developer's insurances void; • insure the relevant sections of the DHS; • not do anything that creates a nuisance, annoyance (etc) to the Developer or occupiers of adjoining site; • observe and perform Site Rules]

	[In respect of the licence granted, the Developer shall: • be responsible for damage to any part of the DHS caused by the Developer; • ensure that no structures/ plant are placed above the pipe routes; • ensure that in the event of an Emergency relating to the pipework, the pipe route is made free of materials and vehicles that would prevent access by the ESCO]
Variations	*[Ability for the Developer to request changes to the Connection (for example, location, capacity). Obligations should be placed on the Developer to provide all relevant information to the ESCO in order for the ESCO to appropriately cost and quote for the variation]*
Payment	*[Developer to pay for cost of Connection]*
Compensation	*[Appropriate compensation mechanisms should be included to offer the ESCO relief where the ability to make the Connection is impacted by the Developer's actions – for example, a delay in the Developer's programme]*
Liability	*[Will be dependent on: impacts of non-performance, performance regime and whether there is an aggregated level of liability across a suite of documents which may include the Concession Agreement, Connection Agreements and Customer Supply Agreements]*
Insurance	*[ESCO required to provide evidence of:* ○ *contractor's all risks* ○ *public liability;* ○ *employer's liability;* ○ *property damage]*
Damage and Defects	*[Clear allocation of liability for damage should be detailed. Responsibility for damage arising from failure of Secondary Networks will be dependent on the adoption process and the extent of liability being taken by the ESCO]* *[Costs of damage to the DHS caused by the Developer should be reimbursed to the ESCO]* *[Costs of damage to the DHS caused by customers may be shared between the Developer and the ESCO]*

	[Liability for costs arising in defects in the Secondary Network will depend on wider commercial arrangements and what risks were passed on adoption]
Termination	*[Grounds for termination of the Agreement, will include:* ○ *insolvency/administration/liquidation;* ○ *material breach/ major default* ○ *unauthorised change in control]* *[Consequences of Termination:* ○ *if termination by Developer for ESCO default, relevant transfer of assets (such as Secondary Distribution Network) back to the Developer* ○ *ESCO removal/ decommissioning of their equipment (as agreed according to the broader commercial arrangements)* ○ *[other consequences relevant to commercial arrangements, including those addressing Supplier of Last Resort]*
Subcontracting/ Assignability/Transfer	*[Generally no subcontracting (etc) without notification and consent, except within limited circumstances.]* *[Developer transfer normally subject to financial Security Tests]*
Confidentiality/ IP	*[Standard confidentiality, subject to any obligations placed on Local Authority, e.g. FOI]* *[Any IP in specific DHS systems should be protected for person developing, depending on commercial arrangements]*
Security	○ *[Parent Company Guarantees]* ○ *[Collateral Warranties]*
Dispute Resolution Procedure	*[DRP provisions to be Construction Act 2011 compliant]*
Boilerplate:	○ Third Party Rights ○ Force Majeure ○ Change in Law ○ Notices ○ Waiver ○ Invalidity and Severability ○ Entire Agreement ○ Governing Law