PARSONS BRINCKERHOFF

December 2015

NEW CROSS HEAT NETWORK: GOVERNANCE AND DELIVERY OPTIONS

London Borough of Lewisham

3514033A-BEL

Final

New Cross Heat Network: Governance and delivery options

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Prepared for
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CONTENTS

ABBREVIATIONS

°C	degrees celsius
ALMO	Arms Length Management Organisation
CO_2	Carbon Dioxide
CRC	Carbon Reduction Commitment
DECC	Department of Energy Climate Change
DE	Decentralised Energy
DHW	Domestic Hot Water
DH	District Heating
EfW	Energy from Waste
EED	Energy Efficiency Directive
ESCo	Energy Services Company
HEFCE	Higher Education Funding Council for England
HIU	Heat Interface Unit
HNMB	Heat Network Metering & Billing Regulations (2014)
IRR	Internal Rate of Return
JV	Joint Venutre
kg/s	kilogrammes per second
kW	Kilowatt
kWh	Kilowatt-hour
LBL	London Borough of Lewisham
LDA	Local Development Agency
m	metres
m^2	Square metres
m/s	metres per second
mm	millimetres
MID	Measuring Instruments Directive
MW	Megawatts
MWh	Megawatt-hour
NMRO	National Measurement and Regulation Office
NPV	Net Present Value
RHI	Renewable Heat Incentive
SELCHP	South East London Combined Heat and Power
SH	Space Heating
SSA	Strategic Site Allocation
TRV	Thermostatic Radiator Valve
W/m^2	Watts per square metre
WSP | PB	WSP | Parsons Brinckerhoff

EXECUTIVE SUMMARY

This sheet is intended as a summary only

This report assesses the economic performance of a proposed New Cross Heat Network connected to Goldsmiths University, Childeric Primary School, Batavia Road housing and the proposed developments at Bond House and Goodwood Road. Note that this does not include all the loads in the preferred network expansion option identified in the *Element B* report, as route proving has not been undertaken for these extensions. Childeric Primary, Batavia Road, Bond House and Goodwood Road have been included in this assessment as they are very close to the SELCHP to Goldsmiths network route.

Heat loads are calculated for each of the connections being assessed. We propose two supply scenarios: one in which the network is sized for peak load supply and one in which it is sized for base load supply. As Goldsmiths has its own boilers, it may be beneficial to avoid sizing network infrastructure for peak heat load as it only occurs for a small proportion of the time and a base load supply can serve the vast majority of the annual heat load from a connection that is less than 40 percent the rating of a peak load connection.

Pipe sizes are developed for the base and peak load supply scenarios. We also present a third option in which pipes are sized for the future-proofed heat network, i.e. the additional loads identified in the *Element B* preferred expanded network. Note that the pipework for connecting these additional future loads is not included in this analysis; but the SELCHP to Goldsmiths pipework is sized to supply these future loads at points where the expanded network would share pipework with the core scheme.

Connection	Base Load Network (kW)	Peak Load Network (kW)	Future proofed Network (kW)
Goldsmiths Education Building	374	1001	1001
Goldsmiths 1 St James	374	1001	1001
Childeric Primary School	37	250	250
Batavia Road	123	770	770
Bond House	78	516	516
Goodwood Road	121	833	833
Convoys Wharf			22,803
Surrey Canal Triangle			14,930
The Wharves Deptford			4957
Grinstead Road			1185
Arklow Estate			1707
Achilles Street			1432
Deptford Green School			1220

The results of detailed energy balance modelling is presented, wherein the supply of heat from SELCHP, including network losses, and on-site boiler usage is modelled against the profiled hourly heating demands developed for the *Element B* report. Parasitic power consumption is also included.

Energy	Base load network	Peak load network	Future-proofed peak network
Heat load (MWh)	5,765	5,765	5,765
Network losses (MWh)	632	705	873
Heat purchased from SELCHP - includes losses (MWh) [a]	5,731	6,391	6,559
Heat sold to end users - excludes losses (MWh) [b]	5,099	5,686	5,686
% heat met by heat from SELCHP	88%	99%	99%
Efficiency of supply [b / a]	89%	89%	86.7%
On-site boiler gas consumption for load not met by heat network (MWh)	762	79	79
Parastic electricity consumption (MWh)	140	156	156

Capital costs for each of the supply options are presented, following input from a DH contractor and drawing on costs from similar projects that have gone to construction.

Peak load	Base load	Future-proofed
£4,120,221	**£3,601,670**	**£5,006,526**

A methodology for calculating the cost of heat from SELCHP is presented along with methodologies for calculating heat sales prices to Goldsmiths and other network connections. For the purposes of modelling, all of these heat costs are varied through time according to the percentage changes implicit in DECC's utility price projections central scenario. Annual maintenance costs and the reduced cost of carbon to Goldsmiths (under CRC) are also included in this analysis. The economic performance of options is then assessed over 25 and 40 year project lifecycles at a discount rate of 3.5%. The results are presented in the following table.

Network type	NPV 25 yr - 3.5%	NPV 40 yr - 3.5%	IRR 25 yr	IRR 40 yr
Base load	-£1,991,633	-£1,424,289	-2.5%	0.8%
Peak load	-£2,375,956	-£1,761,188	-2.9%	0.5%
Future-proofed	-£3,538,880	-£3,005,107	-5.0%	-1.1%

The results show that the scheme does not achieve a positive NPV on the basis of a connection to Goldsmiths and adjacent loads, although additional sensitivity analysis concludes that improvements could be made if the RHI benefit of the scheme to SELCHP and a heat sales price based on a higher year 1 gas price were included in the scheme.

It should be noted however, that the scheme assessed is proposed as a kick start to a wider, area heat network, the economic performance of which has not yet been assessed. Goldsmiths are an existing, significant heat load with a strong interest in connection that can act as an 'anchor load' from which to build the wider network. The *Element A* report concluded that there are sections of the network, particularly around Surrey Canal Road and Trundley's Road, where installation of pipework will be complicated due to the presence of major existing services and the importance of these roads in maintaining traffic flows through this industrial area. Installing a link between SELCHP and Goldsmiths ensures that key network infrastructure is in position as early as possible, so the opportunity to develop a wider network is not lost to, for example, other utilities installing infrastructure along the proposed route. It contributes towards the expansion of the network beyond the connections included in this economic analysis and drives greater economic performance.

To put this in some context, the kick start network assessed here is comprised of 2,361m of DH trench serving 5,765MWh of load annually under a peak load scenario. The annual load at Convoys Wharf alone has been assessed as being in the region of 17,500MWh (see *Element B* report) and would require an additional c. 1km of trench to connect it to the kick start network. This equates to three times the load of the kick start network added for less than half the pipe infrastructure. Furthermore, there are several other major developments planned for the same area, as discussed in the *Element B* report.

Based on the scale of new development in the area, the economic case for a heat network in New Cross appears strong once you factor in the future connections. It should also be borne in mind that these large new developments are obligated to connect to an area heat network under their planning conditions.

Although the base load network is the best performing (economically) of the three options assessed in this report, there are disadvantages to installing pipework that is sized to meet the base load only. Given the scale of new development planned or already in construction in the area, there is a significant opportunity for developers to avoid the requirement to make spatial provision for, and install, their own on-site heat sources. Using the network in this way requires resilience of supply (i.e. other than heat from the SELCHP turbine) but means that the cost of on-site heat provision at these new developments can be captured by the heat network as a developer contribution. In order to realise this opportunity, back-up heat plant (boilers) should be located somewhere on the heat network. This could be at SELCHP, at Goldsmiths or even at one of the new developments. Therefore at this stage, we would suggest that the installation of network infrastructure should take account of the significant opportunities for expansion with pipe sizes that are future-proofed for the provision of peak heat load to the expanded network identified in the *Element B* report.

There are operational considerations that arise from sizing pipework for future load scenarios – for example heat losses will be higher from larger diameter pipework and this will be exacerbated by reduced flow rates, particularly during periods of low demand. This can be mitigated by ensuring minimum flow conditions through the pipe, although this does increase pumping energy consumption. We would note that the benefits of being able to supply much greater heat loads once the significant new development in the area comes forward would far outweigh these temporary operational costs.

The report discusses options for structuring the scheme's delivery, operation and maintenance. Options range from fully public sector delivery to some form of PPP to a fully private model. There are clear benefits to LBL if they engage directly with the scheme as they can bring social and environmental goals (e.g. fuel poverty relief and maximising carbon reductions through wider scheme expansion) into consideration along with traditional economic viability criteria. LBL can potentially bring benefits to a private sector partner by providing lower cost funding, reducing paybacks and private sector exposure. They may also be able to provide expertise during the operational phase, for example metering and billing services, which may already exist to service council housing stock.

In summary, it is concluded that the availability of a viable heat source, an established anchor load and significant future development makes New Cross an attractive location for a heat network. Technical difficulties as identified in *Element A* can be mitigated by early establishment of the core network, from which the expansion and associated economic benefits can stem.

SECTION 1

INTRODUCTION

1 INTRODUCTION

1.1 Background

1.1.1 WSP | Parsons Brinckerhoff was appointed by the London Borough of Lewisham (LBL hereafter) to undertake a feasibility study for a heat network supplying Goldsmiths, University of London (Goldsmiths hereafter) with heat from the SELCHP waste incineration plant. The wider assessment consists of four elements:

Element A: A *route optimisation* study to determine the most effective route between SELCHP and Goldsmith's College;

Element B: A *network expansion* assessment to identify opportunities to establish additional connections to the network;

Element C: A *design* study to identify the technical requirements of the heat network, allowing likely costs to be calculated;

Element D: A *governance and delivery options* study for the heat network.

1.1.2 This report represents the output for *Element D*. Elements *A*, *B* and *C* have already been issued.

1.2 Report structure

1.2.1 This report assesses the heat loads for both peak and base load supply scenarios on a network serving Goldsmiths and a number of adjacent loads, as agreed with LBL. Note that this does not include all the loads in the preferred expanded network identified in *Element. B*. Pipe sizes are then calculated for the base and peak load scenarios as well as a future-proofed scenario in which the expanded network loads are included.

1.2.2 The methodology and results of energy balance modelling is presented for the base, peak and future-proofed supply scenarios. A capital cost assessment is provided along with a detailed summary of the inputs used in the economic assessment, which models operational cash flows based on the results of the energy balance analysis. A whole life cost analysis is then presented for each supply scenario over 25 and 40 year project life cycles. Carbon emissions reductions are also presented against a base case for the base and peak load supply scenarios.

1.2.3 The report then summarises the commercial structuring options for delivering the scheme and comments on the suitability of different approaches, given the objectives and attitude to engagement of LBL and Goldsmiths, as established in a delivery options workshop, which is also discussed. Options for ongoing operational management and maintenance of the scheme are also discussed.

1.2.4 The new Heat Metering and Billing Regulations and Heat Trust scheme are summarised and an explanation of options for metering and billing is also provided. Finally a 'strengths, weaknesses, opportunities and threats' (SWOT) analysis is presented.

SECTION 2

LOAD DEVELOPMENT AND NETWORK SIZING OPTIONS

2 LOAD DEVELOPMENT AND NETWORK SIZING OPTIONS

2.1 Peak and base load supply

2.1.1 Heat network infrastructure can be sized to meet 100 percent of the connected loads' heat demands – a peak load system. Alternatively they can be sized to meet the majority of the demand across the year, but with the very high loads that occur for a small proportion of the year served by each individual customer's on-site boilers. This is a base load network. The key considerations for each option are presented in the table below.

Table 2-1: Peak load and base load system comparison

Peak load system	Base load system
Heat network is able to meet full demand of all connection loads. Potential for SELCHP to provide full resilience of supply by installing their own back-up boiler plant. New developments added to the network in the future may not need to install their own on-site boilers if resilience is available from SELCHP. Potential to avoid replacement of existing boiler plant at connected customers if resilience is available from SELCHP. Pipe sizes increased to meet peak loads at connected customers.	Heat network meets a more consistent level of demand across the year but is unable to supply full demand at periods of high load. Heat loads above the connected base load are supplied from on-site boiler plant at each customer. New developments still required to provide their own peaking / back-up boiler plant. Pipe sizes and pumping costs reduced. The majority of heat load still served from SELCHP despite a significant reduction in the maximum load supplied from the network.

2.1.2 The key benefit to a base load system is that requires a significantly reduced connection size (and therefore smaller DH pipes) but still serves the majority of annual heat load. The reason for this is because peak load is generally significantly higher than the base load; however it only occurs for a small proportion of time. Given the complexities of installing DH pipework in the New Cross area due to the number of existing services and restrictions around installing in certain sections of carriageway; the ability to install smaller pipework could be beneficial in determining feasibility.

2.1.3 The draw back with a base load system is that any future connections that are new developments would still be required to install their own boiler plant. This is not an issue at Goldsmiths, where they already have on-site boilers, but most of the additional loads identified in the network expansion study (*Element B*) are new developments, so a peak load system may provide an opportunity to negate the need to install their own plant. The value of this to a DH scheme is that the capital expenditure required to supply on-site plant – including the cost of the space within which to keep it – can be captured as a connection charge to the developer. Value is added by spreading the costs of resilience across multiple users and by taking advantage of the diversity of uses which reduce the overall peak demands.

2.2 Heat loads for pipe sizing

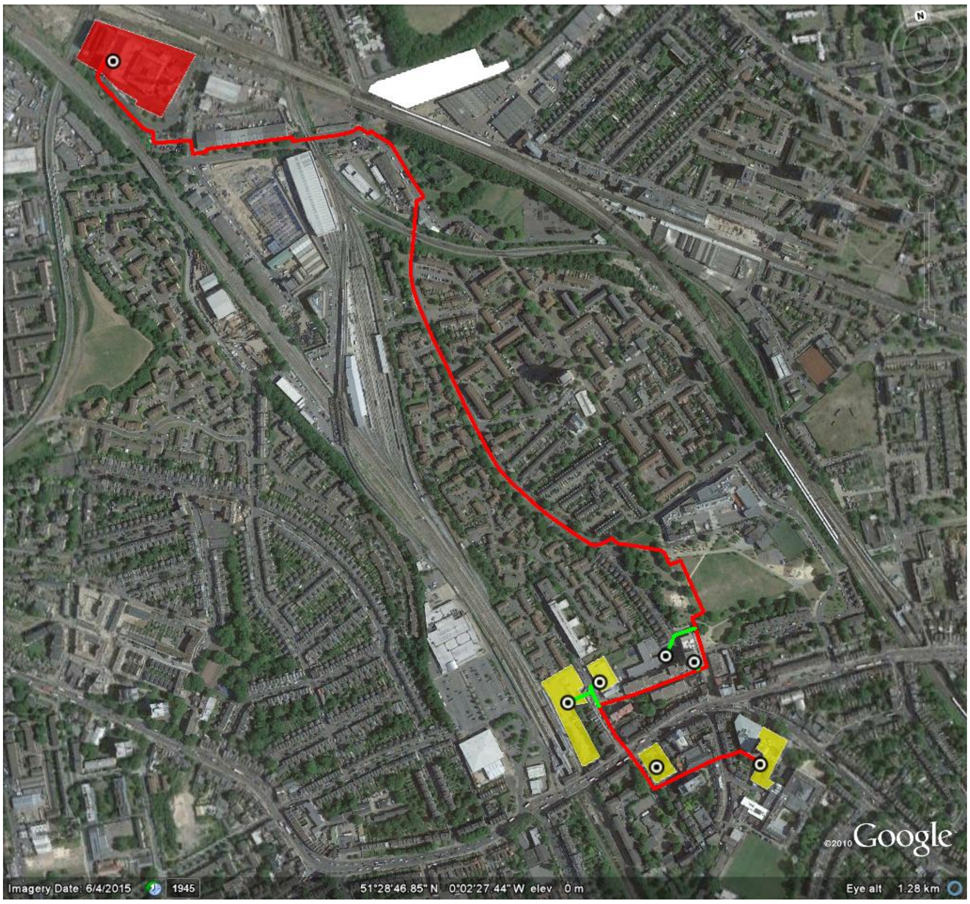
2.2.1 The *Element B* report determined a preferred network expansion scenario based on existing heat loads and known future developments in the New Cross area. In this *Element D* assessment, the economic assessment will be on the basis of the route proved between SELCHP and Goldsmiths in the *Element A* report, with the addition of several loads in the immediate vicinity of this link, as agreed with LBL. Those loads are:

- Childeric Primary School (existing)
- Batavia Road (recently completed development)
- Bond House (proposed development)
- Goodwood Road (proposed development)

2.2.2 These ‘kick-start’ customers provide an anchor load with which to establish a core network, which can then be expanded as new development comes forward. Future economic analysis should therefore be undertaken on the expanded network once detailed route proving has been undertaken for the expansion of the core network

2.2.3 The network being assessed is shown in Figure 2-1.

Figure 2-1: Network extent for economic assessment



2.2.4 Note also that the *Element B* study presented the preferred network expansion option, which was determined through analysis of linear heat density and high level economic performance. Those economic inputs are not project specific and are intended to identify a preferred expansion scheme. The economic analysis presented in this *Element D* study is based on project specific inputs and will therefore give a more accurate impression of the economic performance of the options being assessed.

Peak heat loads

2.2.5 For Goldsmiths' heat load, we have used metered data provided by the University. Note that this data is half hourly and therefore represents the maximum load over a 30 minute period rather than the peak instantaneous load; however, as Goldsmiths have their own boilers and will continue to do so, it is not necessary to provide a connection for instantaneous peak.

2.2.6 Generally in the sizing of pipes for a peak load system, it is the maximum instantaneous load that is important. The pipe must be sufficiently sized to carry the volume of water required to meet the maximum demand on the connected network at any one time. In heating systems, pipes are sized for the 'design peak', which is generally calculated using the heat loss characteristics of the building fabric and the hot water requirements[1]. For loads other than Goldsmiths, we have used the following methodologies to calculate peak load:

- **Residential space heating (new build)**: We have used an assumed fabric heat loss factor of 40W/m^2, based on previous project experience for residential property constructed within the last year. We have applied this to dwelling sizes stated in the development energy strategies where available and used an assumed average dwelling size of 65m^2 where this information is not available. We know that the developments in the vicinity of the heat network will be primarily comprised of flats, so 65m^2 is appropriate for this type of residence. The assumed flat size and heat loss factor for residential space heating demands gives a per-dwelling heat load of 2.6kW;

- **Residential hot water (new build)**: Peak hot water usage has been calculated on the basis of a 35kW hot water interface for each dwelling (assumed to be flats, as stated above). The demarcation of supply for a New Cross heat network at a new development would be a single connection to the customer's distribution system, so it is important to consider the fact that the total hot water load for a development would not be the sum of the number of dwellings and the hot water supply for each dwelling. This is because not all dwellings will be utilising hot water at the same time. In order to account for this, hot water diversity factors have been applied. Diversity factors based on empirical evidence of consumption patterns from Danish Standard *DS 439* have been used in this assessment.

- **Non-residential heating (new build)**: Peak load within non-residential can be calculated using benchmarks published in the BSRIA Blue Book, which is updated each year. These benchmarks take account of both space heating and hot water demand and have been used in our assessment in the absence of site specific energy demand data for each of the future developments that have been assessed;

- **Non-residential heating (existing)**: In order to calculate existing, non-residential peak load, we have applied a load factor to the annual heating demand. The load factor summarises the relationship between peak and annual load across a year (8760 hours) and is calculated by: *Load factor = Annual load / (peak load x 8760)*. The load factors used in this assessment are based on our previous project experience of the relationship between peak and annual loads in existing buildings of different usage types.

- **Return water temperatures**: Return temperature also plays a key role in determining the size of pipework in a DH network. The lower the return temperature, the more heat is delivered per unit of water and the lower the volume of water required to meet the demand, thus smaller pipe sizes can be used. There are several documents that provide guidance on optimum system return temperatures in new developments. The GLA's *District Heating Manual for London* states preferred primary side return temperatures of 55°C for space

[1] Hot water system heat loads vary according to whether they are instantaneous or storage systems. This is explained further in the New Connections Specification provided in *Appendix B* of the *Element C* report.

heating and 25°C for hot water. The Heat Networks Code of Practice for the UK states maximum secondary system temperatures of 70/40°C flow and return for space heating and 70/25°C for DHW (70/45°C where a storage cylinder is used, rather than instantaneous hot water). The Code of Practice highlights that these temperatures should be lowered further where practicable to improve efficiencies on the network, although our experience of customer systems is that return temperatures around 40°C are not commonplace at the moment. It is not clear whether there is an opportunity to significantly influence the design of the new developments proposed for connection to the New Cross heat network; however we have conservatively assumed primary return temperatures of 55°C for space heating and 35°C for DHW on residential dwellings and 55°C for non-residential buildings. This is consistent with the guidance in the *District Heating Manual for London* but makes an allowance of +10°C for hot water return temperatures on the basis that the hot water systems installed in the new developments may not all be instantaneous. Note also that return temperatures are discussed further in the *New Connection Specification* included in *Appendix B* of the *Element C* report.

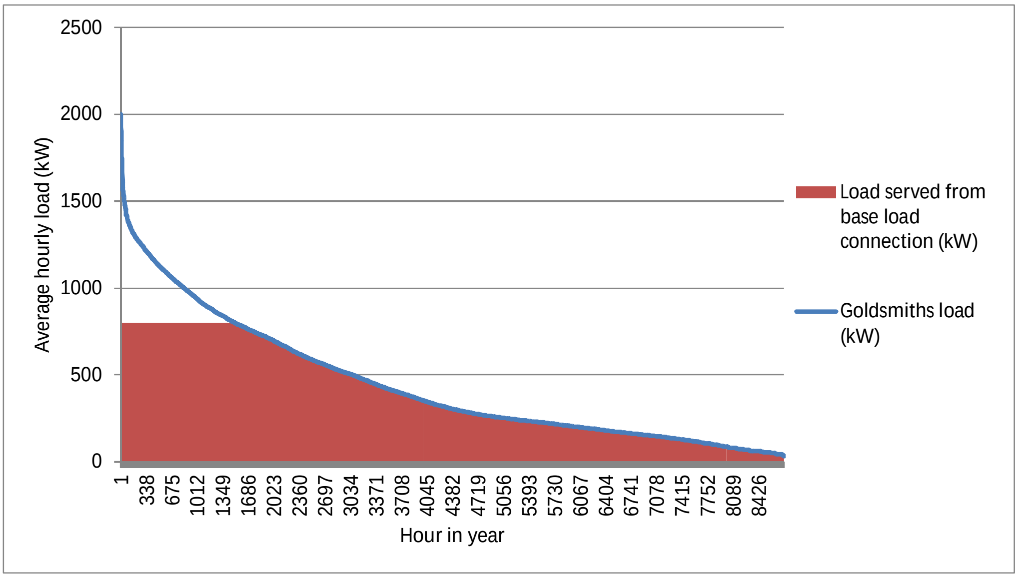
Base load

2.2.7 In order to calculate base load demand, we have used the annual loads presented in the *Element B* report for each of the buildings in preferred network expansion option B (see Table 2-2). For Goldsmiths, we have used half hourly data taken from the metered data provided. For other connections, where only annual heat loads were available, we have used our in-house load profiling software, applying typical daily hot water and space heating usage profiles for different building usage types to distribute annual consumption hourly across a full year. The resulting profiled heat demands have then been assessed to find the connection size at which 7000 out of 8760 hours per year would have a lower or equal heat load.

2.2.8 It is noted that there is no universally accepted definition of base load and, as such, the methodology described above is purely a means of determining a suitable connection size that will ensure the majority of heat load can be served from a connection that is significantly smaller than the peak load.

2.2.9 A graphical representation of the methodology is shown in Figure 2-2. It shows Goldsmith's hourly heat load across the year rearranged in descending order so the peak is to the left and the lowest load is to the right.

Figure 2-2: Goldsmiths load duration curve showing base load heat provision (red)



2.2.10 The chart shows how Goldsmiths has a maximum load of approximately 2MW; however almost 80 percent of the annual load can be served with a connection of 800kW (indicated by the area in red).

2.2.11 Note that the peak in the chart is the maximum hourly load from the metered data provided by Goldsmiths (see Section 3.1 of the *Element B* report for more detail). It is not the instantaneous peak. Nevertheless, the analysis demonstrates how a base load connection means 90 percent of the annual heat load can be served from a connection size that is 40 percent of the hourly maximum load.

2.2.12 The impact of this methodology would be even more pronounced if a base load connection was compared to a design peak connection, e.g. for a new development. Using the example of Batavia Road, the design peak calculated using the methodology described previously is 770kW; however the base load connection size would be in the region of 125kW. Our analysis for this connections shows that approximately 80 percent of the annual load could be served from a connection size that is approximately 15 percent of the design peak load.

2.2.13 In terms of pipe selection, a 770kW connection would be 65mm, whereas a 125kW connection would be 32mm connection, assuming a temperature differential of 55°C (110/55°C primary flow and return). It also means savings in pumping costs due to the reduced volume of water to be circulated.

Summary of peak and base loads

2.2.14 Using the methodologies described above, we have calculated the peak and base load demands for each of the connections being assessed. We have also applied return temperatures to be used in the pipe sizing, using the assumptions described previously. That information is summarised in Table 2-2.

Table 2-2: Loads, return temperatures and assumed year of connection used in assessment

Load	Peak load (kW)	Base load (kW)	Peak annual (MWh)	Baseload annual (MWh)	SH return temp (°C)	DHW return temp (°C)	Non-resi return temp (°C)	Assumed year of connection
Goldsmiths Education Bldg	1,001	374	1,935	1,693			65	2018
Goldsmiths 1 St James'	1,001	374	1,935	1,693			65	2018
Bond House	516	78	416	331	55	35	55	2019
Goodw ood Road	833	121	635	509	55	35	55	2019
Batavia Road	770	123	627	498	55	35	55	2018
Childeric Primary School	250	37	218	176			75	2018
Total	**4,370**	**1,108**	**5,765**	**4,900**				

2.2.15 The table shows how the connected annual load on a base load network is 4,900 MWh, which is 85 percent of the connected annual load on a peak supply network (5,765 MWh). The maximum instantaneous load on the base load network is 1.1MW, which is only 25 percent of the maximum load on the peak supply network (4.4MW)[2].

2.2.16 It has been assumed in our analysis that the scheme will begin operating in 2018, with design development and contractual agreement with SELCHP in 2016 and construction in 2017.

2.3 Pipe sizing

2.3.1 We have used the peak and base loads as well as the expected return temperatures presented in Table 2-2 to model the hydraulic performance of the proposed network (see Figure 2-1). The modelling process assesses the minimum pipe diameter required to deliver heat to each connected customer without exceeding key hydraulic design parameters.

2.3.2 The design parameters used in this assessment relate to the velocity of water in the pipe. Higher velocities in a district heating pipe can be used to minimise the pipe diameter; however when velocities exceed tolerable limits, unfavourable consequences can occur, such as erosion of the pipework and increased pumping costs due to increased pressure losses.

2.3.3 The maximum velocities used in the sizing of pipework are presented in Table 2-3. These values are in line with industry accepted guidelines, such as those stated by Logstor, who are the leading supplier of DH pipework.

[2] Note that the combined maximum load as discussed have DHW diversity applied to the individual customer connections, but has not been diversified back to the energy centre. The pipe sizing exercise in Section 2.3 includes diversification across the whole network.

Table 2-3: Maximum velocities used in pipe sizing

Pipe size (mm)	Maximum allowable velocity in pipe diameter (m/s)
15	0.6
20	0.7
25	0.75
32	0.75
40	1
50	1.15
65	1.5
80	1.75
100	2
125	2.5
150	3
200	3
250	3.5
300	3.5
350	3.5

2.3.4 A comparison pipe schedule for the peak and base supply network options is presented in Table 2-4. The primary flow temperature from SELCHP used in the pipe sizing is 110°C.

Table 2-4: Peak and base load network pipe schedule comparison

Pipe size	Length (m)		
	Base load	Peak load	Future-proofed
32	69	0	0
40	54	0	0
50	27	69	69
65	230	54	54
80	230	256	27
100	1,534	124	0
125	0	1,640	0
150	0	0	354
200	0	0	1,090
250	0	0	0
300	0	0	0
350	0	0	550
Total	**2,143**	**2,143**	**2,143**

2.3.5 The tender specification for this study specified pipe sizes at certain points on the network, as follows:

- SELCHP to the junction of Trundley's Road and Sanford Street: 350mm
- Sanford Street to Goldsmiths: 200mm

2.3.6 The specified pipe sizes are to ensure sufficient future-proofing for the network due to the possibility of additional load connecting to the network, as assessed in the *Element B* report. This represents a third pipe sizing scenario.

2.3.7 We have undertaken our own assessment of pipe sizing for the expanded network option identified in the *Element B* report and can confirm that the sizes put forward in the ITT document are appropriate for the expanded network identified in *Element B* with some additional future proofing. The loads used in the future-proofed pipe sizing as presented alongside the base and peak load scenarios in the following table.

Table 2-5: Loads used in pipe sizing analysis

Connection	Base Load Network (kW)	Peak Load Network (kW)	Future proofed Network (kW)
Goldsmiths Education Building	374	1001	1001
Goldsmiths 1 St James	374	1001	1001
Childeric Primary School	37	250	250
Batavia Road	123	770	770
Bond House	78	516	516
Goodwood Road	121	833	833
Convoys Wharf			22,803
Surrey Canal Triangle			14,930
The Wharves Deptford			4957
Grinstead Road			1185
Arklow Estate			1707
Achilles Street			1432
Deptford Green School			1220

2.3.8 As the structuring of the network delivery is further defined, the scheme design should take account of the owner's intentions for the long-term expansion of the scheme. It may be that a fully private sector led scheme may target the most economically advantageous network, whereas a scheme with public sector input may seek to connect loads with longer paybacks but which deliver additional social and environmental benefits such as reduction in fuel poverty. Structuring options are discussed further in Section 6.1 of this report.

2.3.9 The pipe sizes at different sections of the network for each of the three modelled scenarios are presented in Table 2-6. Note that these sizes take account of cumulative diversity of DHW usage as the network moves back towards the heat source (SELCHP).

Table 2-6: Pipe diameters for each network sizing scenario

Section	Pipe sizes (mm)		
	Base load system	Peak load system	Future-proofed
SELCHP to Sanford St	100	125	350
Sanford St to Childeric Primary	100	125	200
Childeric Primary to Batavia Rd	100	125	200
Batavia Rd to Goodw ood Rd	80	125	200
Goodw ood Rd to Goldsmiths	80	100	150

2.3.10 It is important to note that there are implications if the DH pipe is oversized. Low flow rates in large diameter pipes can lead to significant heat losses as the system water spends a long time in transit between the heat source (SELCHP) and the customer. This is particularly an issue in the summer months, when heat load is low. Minimum flow rates can be achieved with a bypass arrangement at the furthest load (Goldsmiths); however this would mean increased pumping energy to maintain a suitable flow rate. It is important, therefore, that the detailed system design ensures adequate capacity in the pipe for future load conditions without unnecessarily reducing the efficiency of the connection to Goldsmiths. As such, it will be necessary to revisit pipe sizing as dialogue with developers such as at Convoys Wharf and Surrey Canal Triangle continues and the heat network enters the detailed design stage.

SECTION 3

ENERGY BALANCE

3 ENERGY BALANCE

3.1 Inputs

3.1.1 In modelling the energy balance for the proposed network, the limiting factor on supply is the availability of heat from SELCHP. We are advised by SELCHP that their installed heat exchange capacity for district heating is 30MW; however they have space for an additional 10MW of heat exchange equipment.

3.1.2 There is currently one heat customer, London Borough of Southwark, already being served with heat from SELCHP who, according to SELCHP, have a stated maximum heat load of 17MW. The profile of the heat load on the existing customer is not known, so it is not possible to make an assessment of how this coincides with demand on the proposed New Cross network.

3.1.3 We have therefore assumed that there is a maximum heat supply of 23MW available from SELCHP based on the following assumptions:

- 10MW of additional heat exchange capacity is installed at SELCHP;
- 17MW goes to the existing heat customer. This is considered a conservative approach as the peak load on the New Cross network may not coincide with the peak on the existing customer network, meaning there may be more heat available to New Cross at times of peak demand.

3.1.4 SELCHP have confirmed that they would be willing to consider the possibility of installing peaking plant (i.e. gas boilers) into their facility. The benefit of this, as described in Table 2-1, is that new developments would be able to avoid the cost of boiler installation and existing buildings would be able to avoid replacing existing plant.

3.1.5 Of the loads being assessed in this study, all but two of them – Bond House and Goodwood Road – already have their own on-site boiler plant. Bond House and Goodwood Road have not yet been developed. It would be uneconomic to install remote peaking plant at SELCHP solely to meet the peak and back-up load at these two, relatively small, developments. This could be considered if some of the larger loads identified in the *Element B* report (e.g. Convoys Wharf) were to connect to the system. For the purposes of this assessment, however, we have assumed that back-up and top-up boiler plant is installed at each customer site.

3.1.6 A table summarising the inputs to the energy balance modelling is presented in Table 3-1.

Table 3-1: Heat network energy balance modelling inputs

Input	Value
SELCHP heat availability	23MW
SELCHP annual shutdown	2 weeks
Back-up boiler efficiency	86%
Parasitics included	DH pumps DH control panel DH substations

3.1.7 DH network heat losses have been calculated using our in-house pipeline modelling software, which calculates losses through the network for each section of pipe based on the insulation thickness, pipe diameter and the difference between the average temperature in the flow and return pipes and the ambient (ground) temperature (assumed to be 8°C). We have assumed that the pipes installed would have insulation thickness equivalent to Logstor Series 2 insulation.

3.1.8 A summary of energy balance data for each of the three scenarios is presented in Table 3-2.

Table 3-2: Annual energy balance modelling key outputs

Energy	Base load network	Peak load network	Future-proofed peak network
Heat load (MWh)	5,765	5,765	5,765
Network losses (MWh)	632	705	873
Heat purchased from SELCHP - includes losses (MWh) [a]	5,731	6,391	6,559
Heat sold to end users - excludes losses (MWh) [b]	5,099	5,686	5,686
% heat met by heat from SELCHP	88%	99%	99%
Efficiency of supply [b / a]	89%	89%	86.7%
On-site boiler gas consumption for load not met by heat network (MWh)	762	79	79
Parastic electricity consumption (MWh)	140	156	156

3.1.9 The results show the following:

- The peak load network is able to meet 11 percent more of the total heat load than the base load network; however the base load network still serves the majority of total heat load on the network.
- Heat losses increase as pipe diameters increase, with the highest losses on the future-proofed network.
- Efficiency of supply is highest on the base and peak load networks due to the higher heat losses on the future-proofed network.
- Annual heat sales to customers on the peak load and future-proofed networks are approximately 600MWh higher than on the base load network.

3.1.10 We have also modelled the heat losses if pipe insulation thickness was increased to Series 4 – the highest insulation thickness. The results of this analysis are presented in Table 3-3.

Table 3-3: Transmission loss reduction with series 4 insulation compared to series 2 insulation

Network type	Base load	Peak load	Future-proofed
Losses with series 4 pipe (MWh)	480	511	587
% reduction over series 2 pipe	24%	28%	33%

3.1.11 Note that we would expect the losses in the future-proofed network to reduce as additional connections are added in the future as this would increase the velocity of water in the pipe.

SECTION 4

ECONOMIC ANALYSIS

4 ECONOMIC ANALYSIS

4.1 Capex

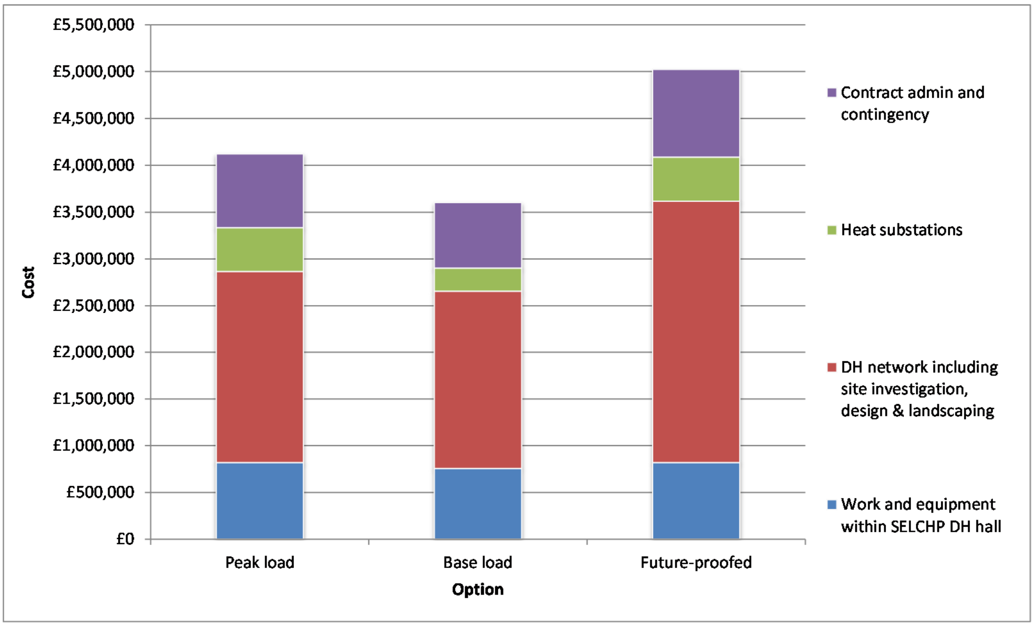
4.1.1 The capital cost of the heat network has been developed in coordination with a DH contractor, who attended site and provided installed, cost per metre rates for different pipe diameters and different excavation types (soft dig, hard dig, mechanical and hand dig). We then applied these costs to each section of the route, according to the type of excavation required. The rates provided by the contractor are presented in Appendix D and include all design, prelims, OH&P, site set-up, and project management costs.

4.1.2 For heat substations, distribution pumps and other ancillaries, we extrapolated costs from three contractor quotations for a recent DH construction project that we are involved with.

4.1.3 We made assumptions about design, consultancy and contingency rates for the project and also made allowance for landscaping, e.g. in Folkestone Gardens.

4.1.4 A summary of the total cost for each option is presented in Figure 4-1. A detailed breakdown of the costs and details of the items purchased each year is included in Appendix A.

Figure 4-1: Option cost by spend category



4.1.5 The total capital cost of each option is presented in Table 4-1.

Table 4-1: Total option cost

Peak load	Base load	Future-proofed
£4,120,221	**£3,601,670**	**£5,006,526**

4.1.6 Note that capital costs have been staggered in line with the expected timing of expenditure, so for buildings assumed to connect after the scheme has become operational (e.g. Goodwood Road and Bond House), the capital cost of additional pipework and the heat substation is modelled to occur the year before the building starts taking heat from the network.

4.2 DH maintenance cost

4.2.1 We have allowed for ongoing maintenance of the DH network at 1 percent of the total pipe network capital cost annually. This is based on our previous project experience of maintenance costs for DH networks. The figures used in the modelling are presented below.

Table 4-2: Annual DH network maintenance cost

Peak load	Base load	Future-proofed
£18,573	£17,102	£26,081

4.3 Cost of heat from SELCHP

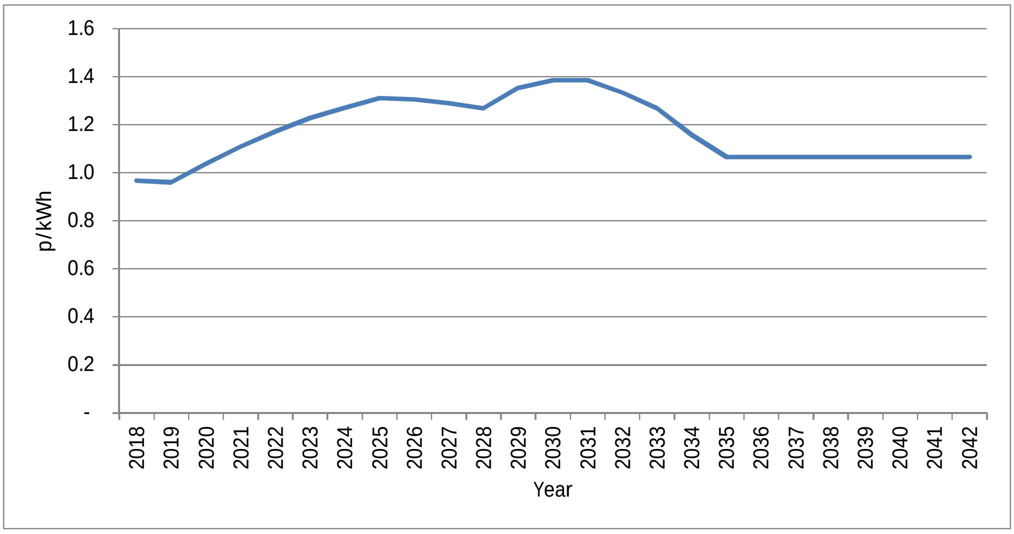
4.3.1 We are advised by SELCHP that for every 5 kWh of heat supplied to the network, they lose 1 kWh of electricity generation and that the cost of heat to the network should be linked to this lost value of electricity. Using a baseload average value for wholesale electricity of 5p/kWh[3], the assumed cost of heat from SELCHP at the moment is 1p/kWh. Note that average wholesale electricity costs have dropped below 5p/kWh recently (4.2p/kWh so far this year); however we have conservatively used 5p/kWh as the year 1 price in our analysis.

4.3.2 As the value of electricity will change over time, we have used DECC's utility price projections up to 2050 to vary the cost of heat from SELCHP. DECC's numbers project the change in energy prices through time based on three energy industry development scenarios – low, central and high. We have applied the annual percentage change implicit in the central scenario to the 1p/kWh 2015 price. The change in SELCHP heat price through time, generated using this process, is shown in Figure 4-2. Note that the scheme is assumed to commence in 2018 (construction in 2017), so the cost of heat is presented from 2018.

4.3.3 A table showing the values in this graph is presented in Appendix C.

[3] https://www.ofgem.gov.uk/monitoring-market/wholesale-market-indicators

Figure 4-2: Cost of heat from SELCHP used in modelling



4.3.4 SELCHP should also be able to claim RHI on the biogenic content of the heat delivered to buildings connected to the heat network (i.e. not including heat losses). Biogenic content is typically assumed to be 50 percent of municipal solid waste. The RHI rate for 'large biomass' (>600kW) from October 2015 is 2.24p/kWh. As such, it is assumed that RHI is paid at 2.24p/kWh on 50 percent of the heat delivered to customers connected to the heat network, or 1.12p/kWh for every kWh of heat consumed by connected loads. Veolia would effectively be covering the cost of lost power generation through the cost of heat to the network operator (1p/kWh variable) and gaining the additional value of RHI payments. It should be noted, however, that RHI can be difficult to claim for this type of project and that the values for incentives such as RHI are subject to Government adjustment at any time - as has been seen with the Feed in Tariff for solar PV recently.

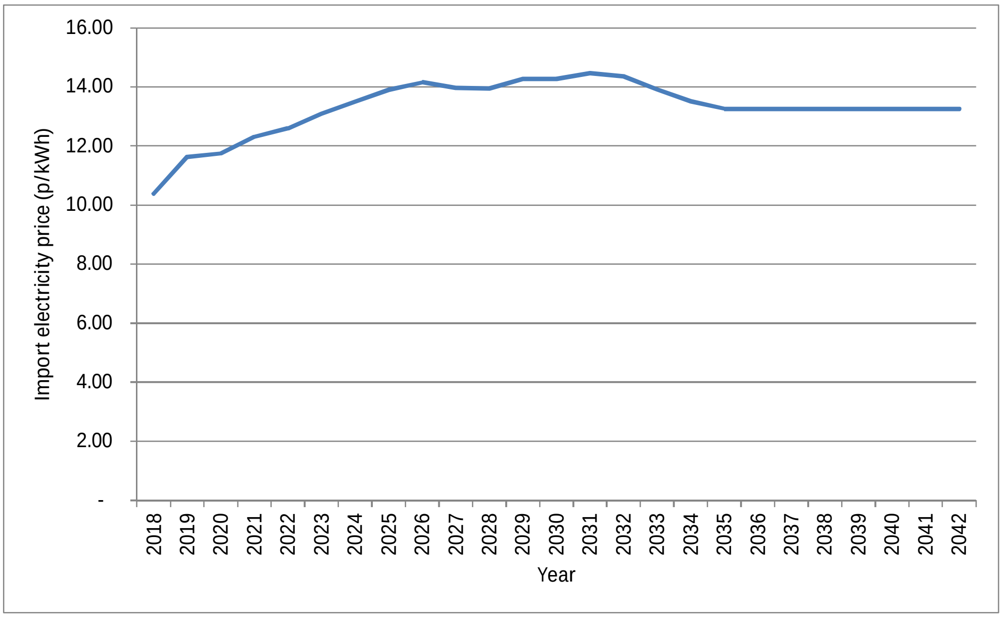
4.3.5 RHI benefit to Veolia has not been included in the base case economic analysis that follows but has been considered in the sensitivity analysis.

4.4 Parasitic loads

4.4.1 Costs for electricity consumed by equipment related to the DH network (pumps, control panels etc) have been modelled on the basis of typical import electricity costs, increased through time in line with DECC's utility price projection central scenario for import electricity. It is noted that SELCHP may choose not to charge for the small amounts of power involved given their site generation capacity; however we have conservatively modelled it as import electricity.

4.4.2 The electricity prices through time used in the modelling are as shown in Figure 4-3. A table showing the values in this graph is presented in Appendix C.

Figure 4-3: Import electricity costs through time as used in the economic modelling



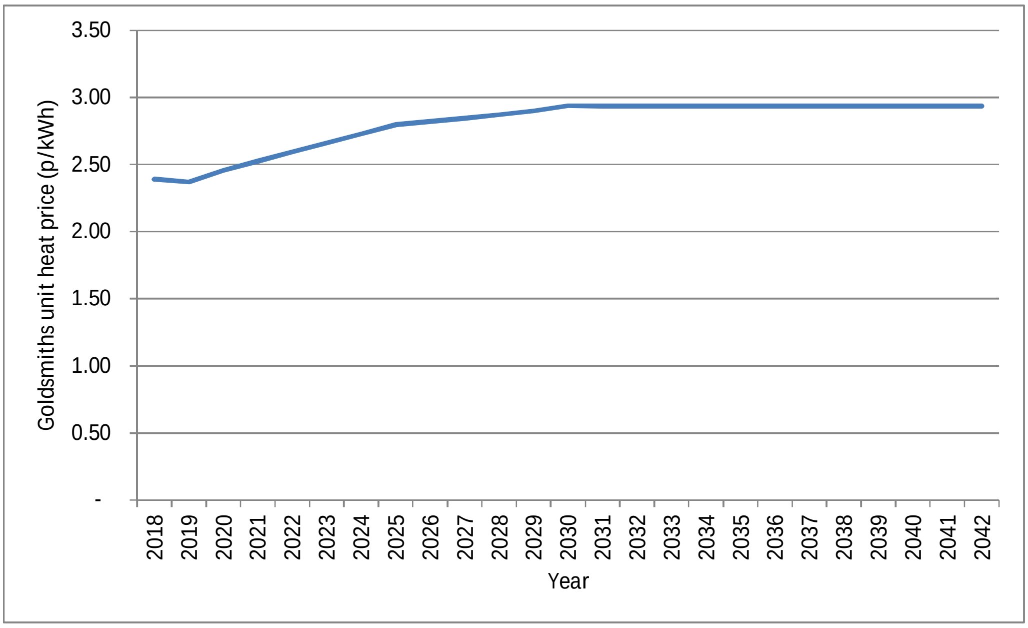
4.5 Heat sales price to Goldsmiths

4.5.1 In calculating the heat sales price to Goldsmiths, we have used their average gas price for 2015/16, which is 1.91p/kWh, excluding the fixed rate charge. We have also included the Climate Change Levy rate of 0.195p/kWh as this would be payable on boiler gas. We have assumed an average boiler efficiency of 86 percent to calculate the cost of generated heat for 2015/16, which is 2.45p/kWh (*cost of gas / boiler efficiency*).

4.5.2 Unitised heat prices have been varied through time in line with the percentage changes implicit in DECC's utility price projections central scenario for gas prices. The 2015/16 price is 2.45p/kWh and the prices from the 2018 start date are as shown in Figure 4-4. Note that the price variations projected do not include for general cost inflation – they are all expressed in today's prices.

4.5.3 A table showing the values in this graph is presented in Appendix C.

Figure 4-4: Goldsmiths unit heat price change through time (2015 base price)



4.5.4 In addition to the unitised cost of heat, we have included a fixed rate cost in line with daily charge Goldsmiths pay to their current gas provider. A daily charge is applied to each of the gas meters on the Goldsmiths campus. We have calculated the daily charge for each of the meters that provide gas to plant rooms that would be supplemented with heat from the DH network, as stated in Section 3.1.2 of the *Element B* report.

4.5.5 The fixed rate price applied to heat sales to Goldsmiths in the economic analysis that follows is £75 per day. It is noted that Goldsmiths would still be required to pay the fixed rate element to their gas provider for each of their gas meters, despite the fact that gas consumption would be greatly reduced by connection to a DH network. The daily charge levied by the gas provider for each gas meter currently varies according to the expected annual gas consumption on each meter[4], so we would expect the daily charge for affected gas meters to reduce in line with expected gas consumption.

4.5.6 Fixed rate charges have not been varied through time in the economic modelling.

4.6 Heat sales price to other customers

4.6.1 In setting a heat sales price for other customers, several things should be considered.

4.6.2 The scheme operator may wish to offer customers a saving over the 'do nothing' alternative, which may include the cost of replacing existing boiler plant. This may be particularly attractive if the scheme's operator is a local authority and the customers are local authority tenants or if the potential customer is a private entity who are not obligated (for example under planning requirements) to connect.

[4] The daily charges range from £0.56 for a meter with approximately 15MWh of gas consumption to £75 for a meter with approximately 5,910MWh of gas consumption.

4.6.3 If a customer is contributing to the scheme in some way beyond just buying heat, this could be secured through an agreed (discounted) heat price. For example if Goldsmiths or one of the new developments (e.g. Convoys Wharf) were to install back-up boiler plant on the primary side of the network, offering resilience of supply to other customers on the network and facilitating developer contributions from the avoided cost of on-site boiler plant, this could be compensated through the heat price offered to that customer.

4.6.4 Where a heat network is linked to other revenue streams, such as private wire connections, which increase the value of electricity generation from e.g. CHP engines or steam turbines from EfW, these savings can contribute to the improved economic performance of the scheme. The operator may then choose to pass some of this saving through to heat customers or, if further expansion of the scheme allows additional social and environmental benefits to be realised, to increase the number of connections.

4.6.5 Where a kick-start network allows the early establishment of a phase 1 project, the operator may agree a heat price for the kick start loads on the basis that additional connections will come forward. This may be a risk to the operator if the economic viability is predicated on unconfirmed contracts. The operator must therefore make an assessment of this risk before deciding to proceed. We would suggest that this is risk is largely mitigated in the case of New Cross as new developments such as Convoys Wharf, Batavia Road and The Wharves Deptford are obligated under their planning conditions to connect to an area heat network should one be available.

4.6.6 Similarly, an anchor load for a kick start network (such as Goldsmiths) could be rewarded for their early engagement, which facilitates the establishment of the network, through a reduction in their heat price, either from the outset or as new customers are connected and the scheme realises its economic potential.

4.6.7 The factors described above are ultimately driven by the goals of the network operator. It is noted that approaches that seek to promote social and environmental benefits rather than focusing solely on economic performance are more likely to be realised through some level of public sector involvement in the scheme. Delivery structuring options are discussed in Section 6.1.

4.6.8 In this analysis, we have based the heat price on the alternative cost of supplying heat from gas boilers, with a unit cost and a fixed rate element. In the absence of a defined delivery structure, this is considered the most logical and equitable means of determining a heat price, but it should be noted that different ownership and operational structures may influence the approach.

4.6.9 For connections such as Batavia Road, where domestic customers are the end user, we have assumed that the heat will be supplied to a single interface (heat substation) within a plant room serving a communal system (as is the case at Batavia Road). Heat will then be distributed to individual dwellings by the customer system. Heat would therefore be sold to each building at the interface (the heat substation), effectively as a commercial customer. The sale of heat to individual dwellings would then be the responsibility of the building secondary system operator.

4.6.10 We would expect Goldsmiths' gas price to be lower than the price paid by other commercial buildings as universities generally purchase their gas on a forward pricing arrangement and often as part of a purchasing group. We have therefore used gas prices for non-domestic customers (including CCL), published by DECC in the September 2015 *UK Quarterly Energy Prices*[5], as the starting point for calculating the heat sales price to other customers.

4.6.11 The UK Quarterly Energy Prices specify gas prices for different levels of consumption. We have used the gas prices appropriate for each connected customer, as follows:

- Bond House, Goodwood Road and Batavia Road: 'small' consumption (between 278 - 2,777MWh/year). Latest 2015 gas price is **2.77p/kWh**.
- Childeric Primary: 'very small' consumption (<278MWh/year). Latest 2015 gas price is **4.51p/kWh**.

4.6.12 As with Goldsmiths, the unit heat price element has been varied through time in the modelling in line with the percentage changes implicit in DECC's utility price projections central scenario for gas prices.

4.6.13 To calculate the fixed rate element we have used the unitised value of the fixed rate element for Goldsmiths

£75 per day fixed rate charge x 365 days / annual consumption [3,869MWh] = 0.71p/kWh

4.6.14 We have then multiplied the annual consumption for each of the other heat customers by 0.71p/kWh in order to calculate the fixed rate charge. This approach links the fixed rate cost to the scale of consumption, as is the case in the gas price data provided by Goldsmiths. The fixed rate costs for each of the other customers are as follows:

Table 4-3: Fixed rate charges used in the modelling

Connection	Fixed rate element (£/day)
Bond House	£8.07
Goodw ood Road	£12.30
Batavia Road	£12.15
Childeric Primary School	£4.23

4.6.15 Fixed rate charges have not been varied through time in the economic modelling.

4.7 Goldsmiths Carbon Reduction Commitment

4.7.1 We have included in the economic analysis the reduction in Goldsmiths' annual Carbon Reduction Commitment exposure as this is one of the core benefits of the scheme to Goldsmiths.

[5] https://www.gov.uk/government/collections/quarterly-energy-prices

4.7.2 Carbon Reduction Commitment is payable on electricity and gas consumption. As the heat from SELCHP consumes neither gas nor electricity in generating the heat, we have assumed that any carbon from heat generation at SELCHP is not reported under CRC.

4.7.3 In assessing the reduction in CRC payments, we have assumed an existing base case of gas boilers of 86 percent efficiency (bearing in mind Goldsmiths are currently replacing the Education Building boilers with brand new ones and the 1 St James boilers will also be brand new).

4.7.4 We have assumed CRC is payable at a cost of £16.40/tonne of CO_2 in 2015, rising to £17.50 in 2016 and then increasing by 3 percent each year until it stabilises at £30/tonne. 3 percent is the average retail price index inflation over the last ten years and this value has been used because the original policy intention was for the CRC cost of carbon to rise in line with inflation up to a cap of £30/tonne. It is noted that the comparatively short term nature of government cycles means the future of CRC is not guaranteed, but it is likely that carbon taxation of some description will remain into the future.

4.7.5 Annual CRC saving over the gas boiler base case for each of the supply scenarios (base and peak load) is presented below. We have used a conversion factor for gas of $0.1836kgCO_2/kWh$[6], which is the factor used in CRC reporting.

Figure 4-5: Avoided cost of Carbon Reduction Commitment exposure (£16/tonne)

Scenario	Goldsmiths load (kWh/yr)	Efficiency of supply	Emissions (tonnes CO2)	Average annual CRC saving: 2018-2042
Base load	3,470,241	86%	740.9	£18,006
Peak load	3,869,013	86%	826.0	£20,075

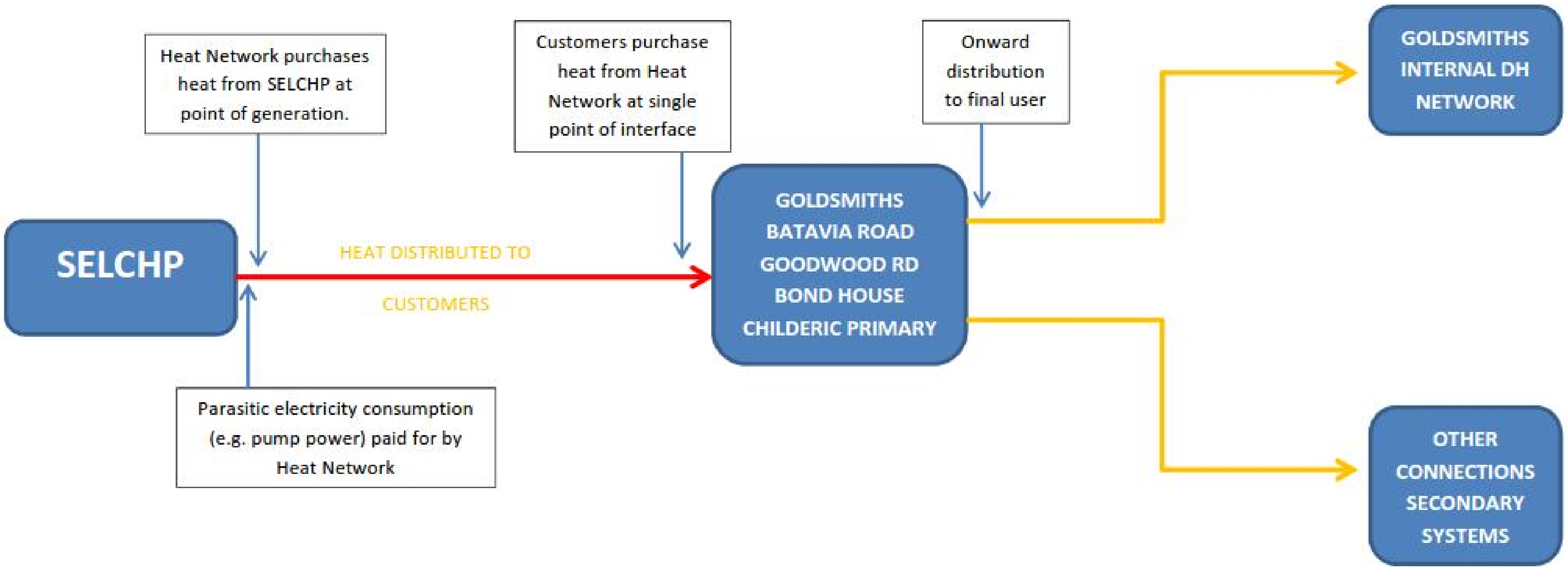
4.8 Results

4.8.1 A flow diagram showing the points of sale and demarcation in the economic analysis is presented in Figure 4-6. Note that this is the system as modelled in this analysis. Alternative arrangements may be possible wherein, for example, centralised boiler plant is included at SELCHP or elsewhere on the primary side of the network to provide resilience of supply.

4.8.2 SELCHP Limited is currently owned by 7 shareholders (according to the latest Annual Return submitted on 16 March 2015). The plant is operated by Veolia Environmental Services. The operator of a New Cross Heat Network (which may be Veolia and/or others) would purchase heat from SELCHP Ltd at a defined boundary within the SELCHP district heating hall.

[6] https://www.gov.uk/government/publications/crc-conversion-factors

Figure 4-6: New Cross flow diagram – as modelled in the economic analysis



4.8.3 The economic performance of the scheme has been assessed over 25 and 40 years at a discount rate of 3.5%. We have also assessed the internal rate of return (IRR) over the same project lifecycles.

4.8.4 Annual operating cost has been calculated on the basis of the following:

- Heat purchased from SELCHP Ltd by the New Cross Heat Network at the SELCHP boundary (i.e. includes DH network heat losses)
- Heat sold to each connected customer at the single point of interface within the customer plant rooms (i.e. excludes DH network heat losses)
- Fixed rate heat charge revenue from connected customers
- Avoided cost of Carbon Reduction Commitment to Goldsmiths
- Electricity consumed for the parasitic demands on the heat network
- Annual heat network maintenance costs

4.8.5 Boiler gas consumption has not been included in this economic analysis as it would be purchased by each building owner/operator and would therefore not be a cost or revenue for the Heat Network operator.

4.8.6 The NPV and IRR values for each of the network options are presented in Table 4-4.

Table 4-4: Economic analysis results

Network type	NPV 25 yr - 3.5%	NPV 40 yr - 3.5%	IRR 25 yr	IRR 40 yr
Base load	-£1,991,633	-£1,424,289	-2.5%	0.8%
Peak load	-£2,375,956	-£1,761,188	-2.9%	0.5%
Future-proofed	-£3,538,880	-£3,005,107	-5.0%	-1.1%

4.8.7 Cash flows through time over 25 years are provided for each option in Appendix B.

4.8.8 The results show that the base load network outperforms the peak load and future-proofed networks and the future-proofed network is the worst performing of the options. We would expect this to be the case as the future-proofed network is sized for a future heat load (heat sales), the value of which is not being included in this economic analysis.

4.8.9 The base load network outperforms the peak load network because the higher heat sales in the peak load scenario are not sufficient to overcome the higher capital cost and higher heat losses over 25 and 40 years.

4.8.10 None of the options achieve a positive NPV over the project lifecycle; however it is emphasised that this assessment does not consider the economic impact of adding the large developments in the area to the network. We would expect the economic performance of the scheme to improve significantly as Convoys Wharf, The Wharves

Deptford and the other preferred loads identified in the Element B report are added to the network, reducing the cost burden of shared sections of network and adding significant heat sales revenue.

4.8.11 To illustrate the likely impact of this, the kick start network being assessed here is comprised of 2,361m of DH trench serving 5,765MWh of load annually under a peak load scenario. The annual load at Convoys Wharf alone has been assessed as being in the region of 17,500MWh (see *Element B* report) and would require an additional c. 1km of trench to connect it to the kick start network. This equates to three times the load of the kick start network being added for less than half the pipe infrastructure. And there are several other major developments planned for the same area, as discussed in the *Element B report*. Based on the scale of new development in the area, the economic case for a heat network in New Cross appears strong once you factor in the future connections. It should also be borne in mind that these large new developments are obligated to connect to an area heat network under their planning conditions.

4.8.12 The primary rationale for developing a peak load network would be to allow end users to avoid using/replacing their gas boiler plant. This requirement would be replaced by centralised gas boilers, either at SELCHP or somewhere else on the network (for example at Goldsmiths). The centralised boilers would provide top-up and back-up (resilience) supplies meaning developer contributions could be sought for the avoided cost of on-site plant, spatial allowance and maintenance at new developments. It may also be possible to seek small contributions from existing buildings which connect, as they are no longer required to maintain or replace their existing boilers.

4.8.13 There may be an opportunity to delay the replacement of new boilers in the Goldsmiths Maintenance Yard boiler house and minimise the installation of boiler plant in the new Goldsmiths 1 St James energy centre when it is developed; however that possibility has not been captured in this economic assessment. It is discussed further in the following section on sensitivities.

4.8.14 No specific location for back up and peaking boiler plant has been identified in this study. Options for location of plant at either SELCHP or Goldsmiths could be considered if the scheme is to be developed further.

4.9 Sensitivity

<u>Heat price variation</u>

4.9.1 We have undertaken further analysis to investigate the change in heat sales price required to achieve an NPV of zero over 25 years. The results are presented in Table 4-5. Note that we have presented the change in Goldsmiths' heat price compared to the modelled 2018 price (2.40p/kWh); however the same percentage increase has been applied to the other heat customers in this analysis. The change in Goldsmiths' price is shown by way of illustration.

Table 4-5: Heat sales price change requirement to achieve zero NPV over 25 years

Network type	Heat sales price change requirement	Equivalent 2018 Goldsmiths heat price (p/kWh)	Change from Goldsmiths 2018 heat price used in modelling (2.4 p/kWh)
Base load	76%	4.22	1.83
Peak load	82%	4.34	1.95
Future-proofed	122%	5.30	2.91

4.9.2 The results show that the 2018 heat price would need to increase by almost 2p/kWh in order to enable the scheme to achieve a zero NPV over 25 years. This represents a significant increase and is unlikely to be acceptable to heat customers unless the ownership costs of gas boiler plant can be offset by use of centralised peaking and back up boilers. It is noted that most calculations of offset costs for total heat supply - i.e. where the value of displaced boilers is captured by the network operator – are in the range of 4.5 to 5.5 p/kWh.

4.9.3 It is noted that current gas prices are low compared to the last few years. In 2013 and 2014, for example, Goldsmiths' gas prices for the main plant room supply were 2.43p/kWh and 2.40p/kWh respectively, compared to 1.91p/kWh in 2015/16. As such, we have assessed the change in economic performance if we increase the 2015 base gas price by 0.5p/kWh. The results of this assessment are presented in Table 4-6.

Table 4-6: Economic outputs with 0.5p/kWh increase in 2015 base heat sales price

Network type	NPV 25 yr - 3.5%	NPV 40 yr - 3.5%	IRR 25 yr	IRR 40 yr
Base load	-£1,445,720	-£705,297	-0.5%	2.2%
Peak load	-£1,767,284	-£959,513	-0.9%	2.0%
Future-proofed	-£2,930,208	-£2,203,432	-3.0%	0.4%

4.9.4 The results show that an increase in the 2015 base gas price improves the economic performance of options but not to the extent that they achieve an NPV of zero or above over the project lifecycle.

Value of RHI included

4.9.5 As described in Section 4.3, the cost of heat from SELCHP to the Heat Network used in the analysis is sufficient to cover the lost electricity generation revenue for SELCHP Ltd. Therefore this analysis assumes any revenue SELCHP Ltd receive from RHI is profit for them.

4.9.6 We have assessed the economic performance in the event that RHI revenue (1.12p/kWh) was factored into the scheme, effectively offsetting the heat sales price to the Heat Network. The results of this analysis are shown below.

Table 4-7: Economic outputs with RHI value to SELCHP included in the scheme

Network type	NPV 25 yr - 3.5%	NPV 40 yr - 3.5%	IRR 25 yr	IRR 40 yr
Base load	-£1,060,190	-£214,505	0.6%	3.1%
Peak load	-£1,337,474	-£412,326	0.3%	2.9%
Future-proofed	-£2,500,398	-£1,656,245	-1.8%	1.2%

4.9.7 The results show that there is a significant improvement in the economic performance of the scheme; however it is still not enough to deliver a positive NPV over 25 or 40 years.

Value of RHI included and heat price variation

4.9.8 Finally, we have assessed the economic performance if the two sensitivities described above are combined, so that the 2015 base heat sales price is increased by 0.5p/kWh and the value of RHI is included in the NPV calculations. The results of this analysis are presented in Table 4-8.

Table 4-8: Economic outputs with 0.5p/kWh increase in heat sales price and RHI value included

Network type	NPV 25 yr - 3.5%	NPV 40 yr - 3.5%	IRR 25 yr	IRR 40 yr
Base load	-£514,278	£504,488	2.2%	4.3%
Peak load	-£728,801	£389,348	1.8%	4.1%
Future-proofed	-£1,891,726	-£854,571	-0.3%	2.4%

4.9.9 The results show that over 40 years, both the peak and base load schemes would deliver a marginally positive NPV, although neither would do so over 25 years.

4.9.10 As a result of the sensitivity analysis described above, we have demonstrated that the economic performance of the scheme is sensitive to changes in the heat price and the inclusion of RHI benefit to SELCHP Ltd.

Potential for Goldsmiths capital savings arising from connection to SELCHP

4.9.11 In addition to savings in Carbon Reduction Commitment, there are additional benefits to Goldsmiths arising from connection to SELCHP. In order to deliver the equivalent carbon reduction, Goldsmiths would, in all likelihood, seek to install their own gas engine CHP. Connection to SELCHP mitigates this requirement, meaning there is an avoided cost benefit to Goldsmiths.

4.9.12 Based on the annual load of 3,869MWh (connected to SELCHP, as analysed in the *Element B* report) and a rule of thumb assessment for appropriate CHP sizing, we propose that a CHP of approximately 400kWth would be suitable for Goldsmiths.

4.9.13 A CHP of 400kWth would cost in the region of £350-£400k based on recent manufacturer quotations. As such, it may be possible to capture some of this saving as a contribution from Goldsmiths. It is noted that this does not include the additional value of space savings related to an on-site CHP plant.

4.9.14 It is also the case that Goldsmiths will benefit from the reduced boiler usage and additional resilience arising from connection to SELCHP. They will benefit from reductions in boiler maintenance costs and may well be able to reduce the capacity of boilers installed into the new 1 St James energy centre when it is developed as the SELCHP connection provides resilience.

4.9.15 In summary, it may be possible to agree a capital contribution from Goldsmiths for connection to SELCHP. Such a contribution would not improve the business case as assessed to the extent that it makes the network economically viable; however would certainly improve the performance of a wider area scheme if other heat loads were connected.

4.10 Assessing costs for new entrants to the network

4.10.1 When there is peak and back-up heat supply available on the heat network, new connections are not required to install their own on-site boilers and therefore benefit from the avoided cost of heating plant that would have been required had they not connected. This is particularly the case for new developments, although existing buildings can also benefit as they are not required to replace and maintain existing boiler plant.

4.10.2 As discussed in Section 3.1, the proposed kick start New Cross Heat Network does not currently make provision for back-up boiler plant at SELCHP as Goldsmiths already have their own boilers. In this instance, any future connections to the network would be required to supply their own boiler plant. It is noted, however, that new connections taking low carbon heat from SELCHP would not be required to provide an alternative low carbon heat source which, currently, would typically be gas engine CHP.

4.10.3 One approach for capturing the benefits to developers of future connections would therefore be to charge a connection fee that is close, or equivalent to, the cost of gas engine CHP at a suitable size. The cost of gas engine CHP plant varies greatly according to the size of the engine and the manufacturer. Small units can be in the tens of thousands of pounds, whereas large (1 MW plus) units can cost over a million pounds. It is recommended that the Heat Network operator assesses the likely required CHP size based on the estimated annual heat load for a new customer and charges a developer contribution that is equivalent to the cost of a CHP engine of that size.

4.10.4 We do not believe it would be beneficial to provide a range of CHP prices at different sizes or a rate per kW as this is subject to market fluctuations. We propose that the Heat Network operator makes an assessment of reasonable cost at the time of connection.

4.10.5 If an expanded heat network is developed and SELCHP take the decision to install back-up boilers, then developers would not be required to install any site heating plant. If this is the case, the Heat Network operator could assess the developer contribution on the basis of the avoided cost of heating plant installation and maintenance plus the value of the development area that would otherwise have been used to site heating plant.

SECTION 5

CARBON REDUCTION

5 CARBON REDUCTION

5.1 Calculation methodology

5.1.1 In calculating the emissions for each of the network scenarios, we have used emissions factors in the Building Research Establishment (BRE) *Standard Assessment Procedure (SAP) 2012* document[7]. Note that the SAP emissions factor for natural gas is different to the gas conversion factor in the Carbon Reduction Commitment reporting methodology (see Section 4.7); however SAP gives us emissions factors for communal heating from waste boilers, so enables us to calculate carbon emissions from SELCHP heat supplied.

5.1.2 The emissions factors are as follows:

Table 5-1: Emissions factors used in carbon calculations

Energy type	Emissions factor (kgCO2/kWh)
Communal heating: heat from waste boilers	0.047
Natural gas	0.216
Import electricity	0.519

5.1.3 To assess the emissions reduction arising from the provision of heat from SELCHP, we have compared the emissions from each network scenario to a base case in which it is assumed all heat is provided by the building's on-site gas boilers at an assumed efficiency of 86 percent.

5.2 Results

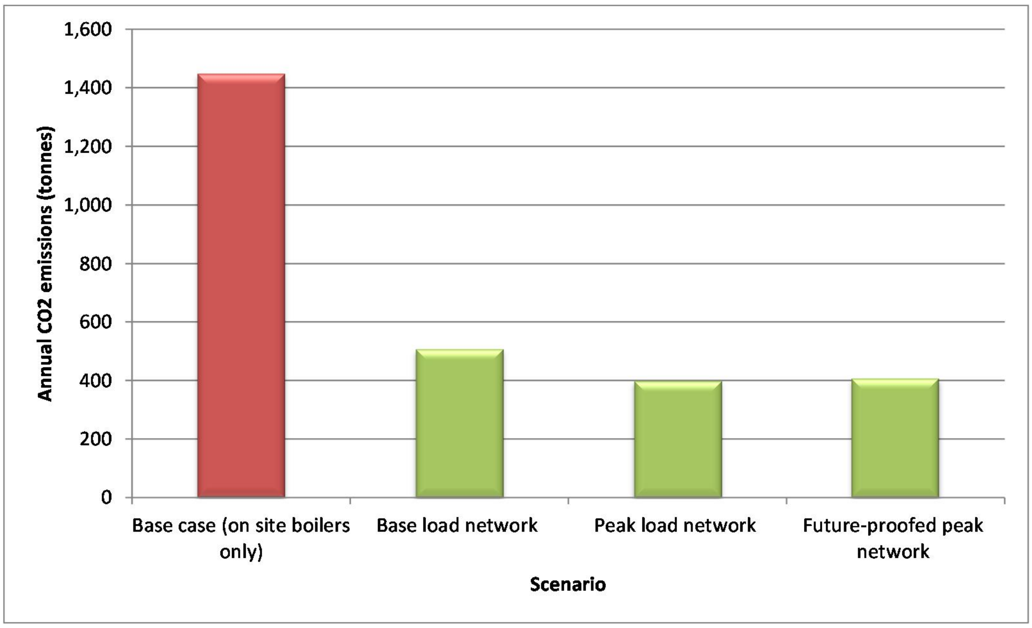
5.2.1 The emissions for each of the scenarios are presented in Table 5-2 and Figure 5-1.

Table 5-2: Scenario emissions

Energy	Base case (on site boilers only)	Base load network	Peak load network	Future-proofed peak network
Emissions from SELCHP heat provision (tonnes CO_2)	0	269	300	308
Emissions from on-site boiler gas consumption (tonnes CO_2)	1,448	164.5	17.1	17.1
Emissions from electricity consumed for parasitic demands (tonnes CO_2)	0	73	81	81
Total (tonnes CO_2)	**1,448**	**507**	**398**	**407**
Saving over base case (tonnes CO_2)		**941**	**1,050**	**1,041**
% saving over base case		**65.0%**	**72.5%**	**71.9%**

[7] http://www.bre.co.uk/sap2012/page.jsp?id=2759

Figure 5-1: Scenario annual carbon emissions



5.2.2 The results show that the provision of heat from SELCHP via a New Cross Heat Network generates significant carbon reductions compared to a base case in which each building supplies its own heat from on-site gas boilers. As would be expected, the peak load network is more carbon efficient than the base load network, despite higher heat losses, due to the reduction boiler gas consumption. The peak load and future-proofed network savings represent a 72 percent improvement over the boilers-only base case.

SECTION 6

PROJECT DELIVERY AND MANAGEMENT

6 PROJECT DELIVERY AND MANAGEMENT

6.1 Delivery structure options

6.1.1 There is a range of potential approaches to the development of district energy schemes, which are summarised in the table on the following page. It should be noted that this list is not exhaustive of all the potential commercial arrangements but it does cover the main types of scheme development that have been undertaken to date. It should also be noted that there is no restriction to using different forms of organisation during different phases of the project life. For example the ownership of the Sheffield scheme was originally a mix of public and private but the local authority disposed of its share once the scheme was developed and could be re-financed. This is a good example of a local authority taking some risk early in a project to reduce the costs of finance and then disposing of its interest once these risks have fallen away.

6.1.2 One of the key factors in determining the method of delivery is LBL and, potentially, Goldsmiths' attitude to engaging in the scheme's delivery and operation. There are clear social, environmental and commercial benefits to be derived from direct participation in such a scheme; however in order to realise them, LBL and/or Goldsmiths would be required to engage in the scheme.

Figure 6-1: Delivery options summary

ID	Description	Funding	Construction	Ownership	O&M	Examples	Potential for LBL commercial benefit	Control over initial connection(s)	Control over network expansion	Potential application
1	Public Sector - traditional	LBL funds Grant funding Over public funds	Public procurement of construction contracts by LBL	LBL direct	LBL internal or public procurement of O&M contract	LB Southwark New Place Estate, Lerwick, Bunhill Heat & Power	Yes	Yes	Yes	LBL procure the scheme and purchase heat from SELCHP, with a demarcation somewhere in the SELCHP facility. The heat is then sold on to heat customers. Full LBL control. LBL take all the risk.
2	Public sector – arms length organisation	LBL funds Grant funding Over public funds ALMO Borrowing	Public procurement of construction contracts by ALMO	ALMO	ALMO direct or public procurement of O&M contract	Pimlico District Heating Undertaking, Aberdeen Heat and Power	Yes	Yes	Yes	As above but LBL set up an ALMO to manage the delivery and operation of the scheme. Potential to avoid public procurement rules and engage in commercial markets. Full LBL control. LBL take all the risk.
3	Public Private Partnership – JV company	Part as Public Sector plus private sector equity plus private sector debt	Public/private sector procurement of construction contracts (depends on JV structure and partner capabilities)	JV Co Ltd	JV Co direct or Public/private sector procurement of O&M contracts (depends on JV structure and partner capabilities)	Thameswey Woking, initial Sheffield scheme	Yes	Partial	Partial	LBL and Veolia as shareholders of a single entity. LBL able to exert influence over priorities such as reduction of fuel poverty, CO2 reduction, prioritising connection of future developments. Shared risk.
4	PPP – split responsibilities (e.g. energy supply private – infrastructure public sector)	Part as public sector plus private sector equity plus private sector debt	Split public/private procurement with interface management	Split public/private	Split public/private procurement of O&M services. Public O&M potentially packaged with private sector partner	Nottingham, Newcastle	Yes	Partial	Partial	LBL and Veolia as partners with different roles, e.g. LBL procure pipe network outside SELCHP, Veolia fund mods in SELCHP and customer interfaces. Benefits as with JV option, i.e. LBL retain maximum possible influence. Risk is shared in part, but can be weighted heavily in one direction (e.g. construction risk if LBL fund the network installation would sit with LBL).
5	Private sector – direct energy services contract	Private sector debt/equity Grant funding – limited availability Supported by contract for services (i.e. to serve prescribed set of end users)	Public procurement for energy services (heat, power) – fixed scope Private sector construction contracts	Private sector –reversion to public after defined period	Private sector	SSE Woolwich, EOn Dalston Square, SELCHP Southwark	Long term	Yes	Long term	The mix of heat customer ownership on the proposed New Cross network means it could not be structured in this way. Infrastructure ownership reverts to public sector once the contract for services has repaid the private sector debt/capital spend. Risk sits with private sector until asset is transferred.
6	Private sector – concession	Private sector debt/equity Grant funding – limited availability. Supported by concession	Public procurement for concession – fixed area/service variable scope (likely base case fixed scope and requirement for future developments to connect). Private sector construction contracts	Private sector –reversion to public after defined period	Private sector	Olympic Park/Stratford City	Long term	Yes	Long term	As with direct energy services contract option above, but the concession covers a fixed area rather than a fixed set of loads. Typically this would be for a new development area where specific requirements can be placed on developers to connect to a network. Not clear how this could be designated for a New Cross network. Risk sits with private sector until asset is transferred.
7	Private sector speculative	Private sector debt/equity Grant funding – limited availability. Underwritten by	Private sector	Private sector	Private sector	Southampton	No	No	No	LBL has no influence over the connected loads, receives none of the commercial benefits but takes none of the risk. Still contributes towards some of LBL's stated drivers – CO2 reduction etc.

6.1.3 The options given in the table above have varying advantages and disadvantages which generally fall under the following headings:

1) Cost of funding

2) Risk versus control

3) Regulations and licensing

4) Availability of resources/skills

Cost of Funding

6.1.4 The cost of funding is critical for DH projects as the cost of infrastructure is generally high and the life of the system long. This has been recognised by central Government who are investigating options for funding arrangements including low cost loans for low carbon infrastructure projects. There has historically been a mismatch between the nature of returns for these projects and the needs of private sector finance. Due to the lack of regulatory structure and high costs of market entry, DH projects are treated individually (i.e. project financed) and the costs of private sector funds is driven by competition with other generally faster return projects rather than as a low risk long term investment.

6.1.5 Generally the public sector has better access to grant funding and funding from other public sector organisations at lower cost than the private sector. Both public and private sectors can generally access funding from the debt markets. Private sector debt is now less easy to obtain and is generally available only on worse terms than has previously been the case. Local Authorities can borrow to invest, and generally are willing to do so if there is a business case based on new revenues. The private sector generally has a shorter timeframe for economic analysis and a stronger focus on pure financial returns than the public sector, which are often able to take account of the value of other potential returns such as environmental and social improvements.

Risk versus Control

6.1.6 Public sector organisations are generally risk averse and there has historically been a tension between the desire from local authorities, and others, to move all risk to the private sector and the desire to retain control over the development of potentially high profile and high impact projects. If there is a full transfer of risk to one party then that party will, naturally, require full control over management of the risks and will be unwilling to allow outside influence on the operation and development of a project. Where a DH project is delivered by the private sector, this may mean that only the ‘lowest hanging fruit’ – i.e. those with the highest returns – are connected to the scheme, whereas the public sector may have been willing to accept a lower rate of return on additional connections on the basis of increased social and/or environmental benefits.

6.1.7 The transfer of risk between the public and private sector also has implications for the cost of funding, and a realistic approach to risk needs to be adopted to give a project a chance of proceeding.

Responsibility for risk has important implications financially for the partners engaged in the development of the scheme. The allocation of risk within a partnership determines how the financial benefits are distributed. Capital and operational risks will have a proportion of finance or a share of profits associated with them – this is where careful consideration of the objectives of Veolia/SELCHP from the point of view of LBL should take place.

Regulations and Licensing

6.1.8 The heat market in the UK is unregulated at present. There are proposals being developed for various types of regulation both at a national and at a London level. This lack of specific regulation may act as both a help and a hindrance to the development of DE. Whilst the lack of regulation provides commercial freedom to develop schemes as required by local circumstances, schemes are generally caught by a range of different regulations related to issues such as town planning, carrying out streetworks and environmental compliance without a national framework for how these will be applied. This can mean a significant amount of work being required to mutually agree the way in which regulations will be applied to this type of scheme and restrictions on ability to access equipment which can create difficulties throughout the project life.

6.1.9 Local authorities can help to get over some of these issues by providing a coordination role for their various departments that will have an input to control of such a scheme, such as Highways, Environmental Health and Planning.

6.1.10 A further issue that will need to be addressed is the extent to which the LA can authorise/empower a private sector partner to deliver DH schemes across the Borough. Careful thought, and legal advice, will be required to ensure that the LA has the necessary powers to, for example, let a concession for delivery of DH schemes Borough-wide or to require/encourage others to connect to such schemes. Any procurement process for this type of arrangement will have to be carefully thought through. There is likely to be a mix of powers available through the planning policy frameworks and other more general powers may be applicable. The potential risks perceived by the private sector in this regard should not be underestimated; private companies will be unwilling to commit significant resources or funds to a process which they are not confident can be completed. In addition, the value that can be placed on commitments by the local authority to require connection to new developments will depend critically on the robustness of these commitments as well as the perceived development risk. For large sites, the London plan provides some significant support to the robustness of LBL requirements to connect to an existing scheme but care always needs to be given to the wording of potential opt outs. Developers have become adept at finding routes to avoid such commitments where "…Unless financially or technically unfeasible." type caveats are included. Such caveats need to have rigorous policing and preferably to set specific standards by which this can be tested to avoid unfounded claims of lack of feasibility.

Availability of Resources and Skills

6.1.11 No matter which delivery approach is selected, both Veolia and LBL will want to ensure that the delivery of the scheme is achieved safely, to programme and to a quality specification. Achieving this requires the use of high quality resources with sufficient experience of delivery of this type of scheme. Whichever approach is taken, those delivering the scheme will need to ensure that they have the ability to monitor progress and quality. It is also the case that LBL may retain some reputation risk whatever the structure adopted for delivery, given their early engagement in the development of the scheme, of which this report forms part, and because SELCHP is within the borough.

6.2 Example Schemes

6.2.1 In this section we discuss how some example existing and proposed schemes have been developed to highlight how the key issues identified in Section 6 have been dealt with elsewhere.

Sheffield Heat and Power

6.2.2 The project was established by Sheffield City Council (SCC) with the operating Company, Sheffield Heat and Power (SHP), formed in 1987 as a Joint Venture between SCC (49% share) and Ekono Oy (51% share) of Finland. Project infrastructure included the modification and ongoing operation of an existing incinerator processing Municipal Solid Waste, which supplies heat to the pipe network. The arrangement between the two main stakeholders was based on a long-term stake and shared risk via a direct equity arrangement. In-kind resources equivalent to £75,000 were committed by both partners with limited recourse funding, implying a consistent whole-hearted commitment by both partners. In 1993 British Gas also invested in the project as a 33% share partner. At this point, all partners held an equal share.

6.2.3 The scheme itself was originally based around connections to public sector buildings – SCC Housing, SCC Corporate Buildings, the two Universities, Weston Park hospital and some Investment Trust owned buildings. The funding was arranged with Japanese Banks and through consolidated loans, which was raised as the project expanded. As the number of connections and confidence in the scheme's cash flows has increased, the scheme has been refinanced at more attractive rates to reduce costs and to inject further capital for expansion.

6.2.4 In 2001 responsibility for operating the network passed to Veolia as part of a 35 year integrated recycling and waste management contract. The key drivers for the project were affordable heating for Sheffield City Council social housing tenants and enabling businesses to develop confidently in the City following the oil price shocks of the late 1970s.

Project Metrics

6.2.5 There are currently over 140 buildings connected to the district heating network that benefit from using the low carbon energy provided by the scheme, generated from Sheffield's own residual waste. These include city landmarks such as the Sheffield City Hall, the Lyceum Theatre and its two universities, in addition to a wide variety of other buildings such as hospitals, flats, shops, offices and leisure facilities. Some 2,800 residential households, mainly in flats, benefit from connection to the scheme across Sheffield. In a typical year around 120,000 Megawatt hours (MWh) of heat is delivered to customers.

6.2.6 More than 44km of underground pipes deliver energy which is generated at Sheffield's Energy Recovery Facility. This converts 225,000 tonnes of waste into energy, producing up to 60 MWth of thermal energy and up to 19 MWe of electrical energy.

Initial Delivery Structure and Governance

6.2.7 Sheffield Heat and Power was formed as a company, limited by shares in 1987, to develop a city wide DH scheme based around heat from an existing incinerator. The company was originally 49% Sheffield City Council and 51% Ekono Oy who were Finnish experts in development of district heating. In 1993 British Gas bought a 33% stake in the company in equal parts from the original investors. There have been a number of subsequent changes of ownership the most recent being to Veolia Environmental Services in 2001. SH&P is now a wholly owned subsidiary of Veolia.

6.2.8 Before this latest change of ownership the company was managed under a traditional board structure originally with a Sheffield City Councillor as Chairman. The management is now fully integrated with Veolia's wider energy from waste business.

Funding

6.2.9 Originally the development costs of the project were met by the partners who each committed in kind resources of £75,000 to move the project to a point where non-recourse financing of an initial £8million could be arranged via a Japanese bank. This allowed the scheme to undertake the initial modifications of the incinerator and install sufficient mains to prove the operational viability of the scheme. Once this was achieved – over a time frame of 3- 4 years – the relatively expensive initial project finance could be replaced and added to allow for the scheme to expand steadily. Additional project finance was raised to allow a steam turbine to be added, supported by a contract under the Non Fossil Fuel Obligation in the 1990s.

6.2.10 The most recent investment in the project was the replacement of the original incinerator and upgrading of the steam turbine in 2006 as part of the long term waste management PFI scheme with Veolia.

Advantages and disadvantages of the chosen structure

6.2.11 The initial delivery structure allowed the original project objectives to be achieved in that a city wide district heating scheme using very low carbon waste heat was built from scratch in a relatively short period. The scheme was delivered without the need for SCC to secure loans and the rapid development of a viable business allowed finance costs to be reduced quite quickly.

6.2.12 The City now benefits from very wide scale low cost low carbon heat and this has supported developments in the city centre.

6.2.13 The council was required to commit significant resources to the project to support their end of the shareholder agreements with Ekono. The latter was however able to bring all the necessary expertise in DH development to enable a very large scheme to be delivered at low risk.

6.2.14 The council was also able to exit the scheme over time and realise financial benefits – in this case in the terms of a cost effective waste management deal with Veolia.

6.2.15 Interestingly the subsequent transfer of ownership of the company to Veolia has shown some of the disadvantages of a wholly private sector approach to district heating. The rate of development in the scheme, in terms of new connections, has fallen off. The Council now has little control over the operation and decision making in the scheme, other than via its own heat supply contracts, and is now seeking to develop other DH schemes independently of SHP.

Replicability

6.2.16 The approach adopted by Sheffield City Council is likely to be suitable to be adopted by other public sector bodies particularly where there is a desire to deliver commercial and development support benefits and a level of risk transfer and expert support is desired. It is also particularly suitable where the public body wishes to ensure a straight forward divestment strategy is in place from the outset.

6.2.17 The approach is unlikely to be suitable where the project is unlikely to deliver return on investment in the medium term; the public sector body does not wish to participate actively in development of the project; or there is a lack of capital or development funding available.

Illustrates

- Ability to divest from Company Limited by Shares
- Potential disadvantages of private sector ownership - lack of expansion and investment in network since divestment
- Potential for future expansion
- Reinvestment of income
- Management of delivery risks

London Borough of Islington

6.2.18 London Borough of Islington Energy Services own and operate the Bunhill Heat and Power network. This currently comprises an energy centre and heat network supplied by a 1.9MWe gas CHP engine and 115m3 thermal store. The network comprises one kilometre of insulated district heating pipework. The £3.8 million energy centre and heat network were part funded by grants secured from the Greater London Authority and the Homes and Community Agency.

6.2.19 LBI procured a design and build contract and a 10 year maintenance contract to provide assurance to the council and in 2012 Vital Energi successfully built the energy centre and heat network. The council manages the operation of the scheme, gaining revenue from electricity and heat sales. This enables Islington to get the most out of the scheme and pass savings on to residents via reduced energy bills. This approach also creates opportunities for Islington to further expand the heat network and develop further heat network opportunities across the borough and potentially across borough boundaries. The current network has been future proofed to enable both organic and strategic growth in future.

6.2.20 Bunhill Heat and Power is planned to help new developments meet their planning energy targets, and the council is currently working to extend the network to connect new build developments to supply them low carbon heat at competitive rates. Over 160 new build homes have already been connected to the network.

6.2.21 LBI is currently developing phase 2 of the network with potential additional heat recovered from tube ventilation systems and a UKPN substation.

Illustrates

- Local authority undertaking wholly publically owned network
- Approach to procurement
- Delivery of cost/social/environmental benefits
- Potential for future expansion
- Reinvestment of income
- Management of delivery risks

Lee Valley Heat Network

6.2.22 London Borough of Enfield decided to set up LVHN Limited in December 2012, ‘LVHN Ltd’ to lead delivery of the proposed Lee Valley Heat Network. This will supply heat from the Edmonton energy from waste plant eventually extending across three London boroughs. This local authority controlled company was programmed to become a reality during 2014/15, with its own Board and staff; however no official announcement has been made to date. LBE states that “LVHN Ltd is being set up as an ‘ethical operator’ in what is currently an unregulated heat market”.

6.2.23 The aims of the LVHN are to deliver:

- Community Energy – low carbon energy to local communities from local heat sources
- Fair Price - to protect consumers by ensuring fair price and customer service terms
- Lower Cost of Heat – ambition to provide lower cost heat for residential customers, as compared to heat from fossil fuels
- Security of Supply
- Route to Market –for low carbon and zero carbon suppliers of heat
- Supports inward investment, new jobs and wider regeneration
- Carbon Reduction - reduce London's carbon dioxide emissions by around 200,000 tonnes over the life of the project

6.2.24 LVHN is currently procuring three contracts:

1. Design, build and operation of the main District Heating Energy Centre
2. O&M framework for a number of smaller energy centres which will be connected to the main system later
3. Customer services for all connected customers

Illustrates

- Other authority undertaking wholly owned network
- Approach to procurement and management of delivery risks
- Delivery of cost/social/environmental benefits

<u>Gateshead ESCo</u>

6.2.25 Gateshead Council is in the process of setting up a wholly owned ESCo specifically to be able to trade with private sector organisations. Initially the energy centre will serve nine public sector buildings, however, it has been future proofed for considerable expansion. The initial connections planned originally included around 400 homes in multi-storey tower blocks and six public buildings. The supplies to the public buildings will be both heat and power via a private wire network. Each of the public bodies has assured themselves that they have complied with necessary procurement requirements with a key element being the offer of a discount against current supplies. The local interest has been such that the initial phase will now also include Hilton Hotel, Jurys Inn Hotel, and Baltic Place offices.

6.2.26 Future phases could also provide heat and power supply to other homes, offices, shops and hotels across the town centre. Studies to connect these additional phases are underway at the urging of the potential customers even as the construction of the initial scheme is getting underway. Further studies into separate schemes on the fringes of Gateshead are also planned.

6.2.27 When operational the district energy scheme will help alleviate fuel poverty and will provide a real advantage for businesses based in Gateshead's town centre.

6.2.28 The wholly-owned Energy Services Company (ESCo) will be responsible for the operation, management and associated billing service. The company will also deliver other energy projects across the Borough including separate communal heating schemes for social housing – some of which will have mixed funding including ECO.

6.2.29 The Council's objectives for the district energy scheme are:

- To provide low cost heat and power - reduced running costs and improve competitiveness
- To create new business growth in Gateshead
- To reduce Gateshead's carbon footprint,
- To help fuel poor households reduce the cost of heating their homes.

6.2.30 The initial town centre project is being fully funded by the Council from their own resources including borrowing from the Public Works Loan board.

Illustrates

- Other authority undertaking wholly owned network
- Approach to procurement and funding
- Delivery of cost/social/environmental benefits
- Potential for future expansion from initial public sector base
- Revenues available to meet authorities strategic objectives

<u>Bristol Energy Company</u>

6.2.31 Bristol City Council's Cabinet has set up a wholly owned energy company, launched in summer 2015 during Bristol's European Green Capital year. Bristol is one of the first local authorities in the UK to look into municipal energy supply and the plans for what Bristol Energy could offer are wide-reaching. Currently it is proposed that the company would be wholly owned by the council and offer people a viable, trusted and accountable local energy company.

6.2.32 The aims of the company would be to offer customers competitive, fair and simple energy tariffs with any profits reinvested back into local communities. The company would also provide locally generated low carbon electricity, offering customers cleaner, greener energy. Another key aim is to improve the City's energy system resilience. Finally the Council would intend to reinvest revenues from the scheme in low carbon energy projects across the city and the southwest of England.

6.2.33 The council is also proposing to deliver planned district heating networks – with the first major scheme to connect the Bristol Royal Infirmary, Bristol University and Bristol City Council social housing. A Memorandum of Understanding is in place between the three parties for this scheme. Business Cases for the three parties are currently in the final stages of preparation.

6.2.34 In 2012 the council applied to the European Investment Bank for funding to undertake feasibility studies for an energy company. Funding was granted which has helped to pay for the resource to establish plans for the new company. Inspiration for the business comes from European models from Germany and Scandinavia where a number of successful municipal energy companies operate.

Illustrates

- Other authority undertaking ESCo as a wholly owned network
- Approach to procurement
- Delivery of cost/social/environmental benefits
- Potential for future expansion
- Reinvestment of income

6.3 Strategic goals and priorities

6.3.1 Before determining which of the possible delivery models would best meet the priorities of LBL and Goldsmiths, we must first define those priorities. WSP | PB held a delivery options workshop with Goldsmiths and LBL departmental officers to discuss the delivery models and the potential risks and benefits of the scheme. Several key priorities were identified through this process, as follows:

Reduce CO_2

6.3.2 One of the primary benefits identified by both LBL and Goldsmiths is the reduction of CO_2 emissions. LBL have a carbon reduction target of 44 percent against a 2005 baseline by 2020. Goldsmiths are trying to achieve the Higher Education Funding Council for England (HEFCE) target of a 50 percent reduction in CO2 by 2020 against a 2005 baseline.

Ability to influence future heat sources

6.3.3 By connecting buildings to a heat network, LBL can influence the provision of heat in the future, beyond the expected life cycle of the SELCHP facility (advised by Veolia to be 25 years from now). The ability to control future heat provision across connected buildings is attractive as it ensures LBL can prioritise carbon reduction. Private building owners may not do the same unless energy markets are such that low carbon heat offers a clear economic benefit.

Reducing fuel poverty

6.3.4 Recent increases in fuel costs suggest that fuel poverty will be an increasingly influential factor on deprivation. Connection to a heat network can enable the local authority to shield vulnerable residents from the impacts of fuel poverty by maintaining control over the heat price.

Energy security and resilience

6.3.5 Decentralised energy networks can help ensure energy security as it protects customers from volatile energy markets and removes the reliance on finite fossil fuel resources. Note that heat from SELCHP Ltd could be linked to energy markets if the heat price is based on the avoided value of electricity sales to the grid; however if SELCHP Ltd sell their power on a private wire basis then this would insulate power sales from market fluctuations to some extent.

Encouraging development

6.3.6 An established DH scheme with peak supply and resilience will encourage developers to come to an area as it removes the requirement for the provision of space for on-site plant (e.g. boilers) increasing the available development density; and contributes towards development emissions standards.

6.3.7 It is clear from the stated aims and perceived benefits that there are multiple social and environmental, as well as commercial, factors that LBL and Goldsmiths would seek to address through a New Cross Heat Network. As such, of the potential delivery structures identified in Section 6, those allowing a degree of LBL control would appear to be the most attractive. The ability to engage in such a delivery structure and realise an element of control is, however, dependent on LBL's willingness to accept some of the risk, as discussed in Section 6.1.6.

6.4 Opportunities for LBL to engage

6.4.1 In determining whether, if the opportunity was available, LBL and potentially Goldsmiths might want to engage in the scheme's delivery and/or operation, there are several things that should be considered.

Providing funding

6.4.2 As discussed in Section 6.1, the public sector has better access to grant funding and funding from other public sector organisations at lower cost than the private sector. By leveraging funding in this way, LBL can contribute to the capital funding of the scheme, giving them a percentage stake and allowing them to play a role in its development and expansion. This approach can also bring benefits to a private sector partner (in this case Veolia), as the delivery risk is shared with the public sector and lower cost funding improves the overall economic performance of the scheme.

6.4.3 In making a decision LBL will have their own investment criteria, one of which would obviously be a return on investment; however it is noted that social and environmental benefits (e.g. carbon and fuel poverty reduction) and broader economic development potential may well also be key factors in determining their willingness to engage.

LBL waste supply agreement

LBL has a waste supply agreement with SELCHP Ltd which, we understand, is up for renewal in the near future. During the renegotiation of this waste contract the Council may wish to consider the potential advantages to the Borough of making maximum use of resources from within the Broough – i.e. waste. This would provide an additional interest in the heat network and in maximising the recovery of energy to support development and emissions reductions. It is likely that any new waste contract would include requirements to ensure that waste treatment meets London Plan requirements.

Attitude to risk

6.4.4 If they engage in the scheme, LBL would need to accept some of the risk in order to influence the scheme and secure some of the desired benefits. The key point here is that risks should be managed by the most appropriate party. The private sector should be able to manage construction and operational risks, but demand risk – i.e. the risk that new developments do not progress as expected – is difficult for the private sector to meet. This is where LBL could take a view on the need to invest in infrastructure to support development ahead of actual build.

Availability of personnel

6.4.5 The current political climate with regard to local authorities means that it may be difficult for LBL to commit personnel to the management/operation of a heat network in the event of collaboration between the public and private sector. If this is to be a possibility, it would be essential to identify revenue which could support the LBL staff and seek to insulate these roles as part of a separate business.

6.5 Matching objectives and engagement opportunities with delivery options

6.5.1 Section 6 identified the potential options for delivering a DH network; Section 6.2 provides some examples of delivery mechanisms used elsewhere; Section 6.3 defined the scheme's strategic goals and priorities for LBL and Goldsmiths; and Section 6.4 summarised the ways in which LBL might be able to engage. Taking all this into account, there appear to be several delivery options that are more suited to these circumstances than others.

6.5.2 A fully public sector led scheme, i.e. options 1 and 2 in Figure 6-1, would require LBL to accept all of the risk and would require the allocation of resources in order to operate and manage the scheme. They would then retain full control of the extent of the network (i.e. the expansion from the initial kick start scheme), which would enable them to ensure their desired goals are prioritised (see Section 6.3). The risk exposure and requirement for resources may make this less attractive to LBL than a model in which they share the risks and benefits with a private sector partner.

6.5.3 A fully private sector led scheme (i.e. option 7 in Figure 6-1) would not afford LBL any influence to ensure strategic goals and objectives are met; however they would not be required to accept any of the risk.

6.5.4 The more attractive looking options are therefore those involving a degree of partnership between the public and private sector. Option 5, wherein the public sector agrees a contract for services with the private sector, is unlikely to be applicable in the conventional sense of LBL agreeing the supply of heat from SELCHP to public sector owned buildings. Most of the loads being considered for extension of the heat network (as identified in the *Element B* report) are private developments, so it would not be possible for LBL to agree a contract for the provision of heat to those connections

6.5.5 A private sector concession is also unlikely to be feasible because the majority of loads other than SELCHP would be private developments so the public sector would not be able to procure the concession.

6.5.6 The remaining collaborative options, as described in Figure 6-1, are a joint venture or a public private partnership. A joint venture would require LBL and Veolia to form a single entity to operate the heat network. This is less likely to be viable as it would require LBL to allocate significant resources to the operation of the company which may be difficult in the current political climate.

6.5.7 A public private partnership may be possible as LBL could, for example, borrow money to contribute to the capital funding of the scheme and then assume responsibility for a part of the scheme's operation. For example they may, through existing responsibilities on local authority housing estates, already be set up to undertake certain operational roles such as metering and billing. However this approach would have to be constructed in a way that is acceptable to both parties and represents an equitable distribution of benefits and risk.

6.5.8 It was included in Section 4.8 that the economic viability of the scheme requires the expansion of the network beyond the initial kick start loads included in the economic analysis presented in Section 4. LBL's ability to provide low cost finance options, which helps reduce and spread the risk around initial capital outlay, could be therefore attractive to a private sector partner under these circumstances. LBL can also potentially bring additional loads to the scheme to improve the viability.

6.5.9 LBL will need to work with their internal stakeholders and Goldsmiths to understand the appetite for engaging in some type of PPP arrangement and also to establish the procurement requirements of such a scheme.

6.6 Management of the heat network infrastructure

6.6.1 Heat network installation and maintenance is a specialist field, however some of its maintenance practices are the same as the more established and common place practices in facilities management.

6.6.2 The pipe infrastructure itself generally requires minimal maintenance if designed and installed correctly; and has a life expectancy of 30 years or more. However there is still potential for issues requiring maintenance of the pipework, such as:

- Structural failure of the pipework (e.g. due to high stresses);

- Ingress of ground water into the insulation (e.g. due to damaged outer casing)
- Damage from a strike (e.g. from excavation around the DH pipe)

6.6.3 Other areas of the heat network require more regular maintenance and are essential to ensuring the continued performance of the scheme. Heat substations are particularly important as they are the point of interface for the exchange of heat to secondary systems and include multiple items that are susceptible to reduced performance if not maintained properly – e.g. valves, pumps, and the heat exchanger surface. These maintenance practices are more commonplace and widely available in the market as they are largely the same as standard HVAC system maintenance.

6.6.4 Water quality is also essential to the continued performance of the network. Poor quality system water can lead to fouling of the heat exchange surface and corrosion/erosion of the pipework.

6.6.5 It is noted that some maintenance can be carried out automatically through the installation of equipment, for example with filtration and chemical dosing systems to maintain water quality. These everyday systems should be included in the design to ensure a minimum level of protection. Other maintenance and testing requirements should be carried out periodically by suitably qualified professionals to ensure that the system continues performing as it should.

6.6.6 Although there are many different variations and permutations of maintenance procurement, they can all be put into one of the following categories:

1) In-house expertise (e.g. local authority and/or Goldsmiths facilities maintenance team);
2) Single source maintenance contractor
3) Maintenance management service provider

6.6.7 The difference between the last two options is that a maintenance service provider typically subcontracts different elements of the maintenance, overseeing the management of the whole process, whereas a single source maintenance contractor would provide all the necessary services themselves.

6.6.8 There is no single best route for procuring management of the heat network infrastructure. It depends largely on the ownership of the infrastructure and the connected buildings. It is noted, however, that the selection of a single source maintenance contractor could be detrimental as not all contractors are specialists in all elements of heat network delivery. For example the contractors who are most skilled at installing and maintaining the buried pipe system may not be as adept at installing and maintaining the mechanical interfaces (substations). As such, there may be a benefit in procuring a maintenance management service provider, who can pool specialist resources under one contract.

6.6.9 In-house expertise may be available for the maintenance of substations; however in this instance, as the connections are not single ownership, i.e. they are not all LBL-owned or Goldsmiths-owned buildings, it would be complicated to structure the maintenance this way. It is therefore recommended that maintenance is outsourced in some way as per options 2 or 3 above.

6.6.10 There are multiple types of maintenance contract arrangement that can be used in the provision of services for ongoing management of a heat network, as follows:

- *Service level agreement*: The contractor must maintain a set of defined performance standards. The means of achieving them is undefined.
- *Inspection and maintenance agreement*: The contractor inspects plant at predetermined intervals and undertakes certain, generally low level maintenance duties for a fixed sum. Additional maintenance, i.e. outside of the defined basic maintenance items, is charged additionally.
- *Planned preventative maintenance agreement*: The contractor undertakes predetermined maintenance work and replacement to an agreed plan. This has the aim of improving the economic life of the plant but can be more expensive as it is less responsive in its nature and may therefore cost more.
- *Measured contract*: The contractor charges the client for time and materials as used. This is unlikely to be the most beneficial for a new heat network as it does not typically entail a defined routine for maintenance.
- *Fully comprehensive maintenance agreement*: The contractor charges a fixed rate to cover the man hours and materials for any and all maintenance over a defined period. This is likely to be less cost efficient to the client as the contractor carries all the risk so is likely to price accordingly.

6.6.11 Given that the infrastructure for the heat network is new, we would suggest that periodic routine maintenance is undertaken, as in the *inspection and maintenance agreement* option described above. This approach sets a fixed price baseline for maintenance activities, which can be defined in the tender documentation, with additional items typically included in a schedule of rates.

6.6.12 The risk with the *inspection and maintenance agreement* approach is that it doesn't incentivise the O&M contractor to deliver high quality service in the same way that a service level agreement does. We therefore recommend that the appointment process gives confidence in the technical capabilities of the contractor and also ensures the contract lists the apparatus to be included in routine maintenance checking and replacement.

6.6.13 It may also be the case that not all contractors are familiar with DH scheme maintenance. Appointment of a contractor should therefore require them to demonstrate the appropriate level of experience

6.6.14 It may be possible to enter into a *service level agreement* for e.g. a CHP-supplied heat network, where the contractor is incentivised to optimise the operational performance of a system to keep the engine running. We have seen this approach used before; however we would suggest that it is difficult to structure the agreement in a way that is acceptable to both parties as it typically involves a compensatory element if the required service level is not achieved. A contractor would also be unlikely to agree to such an arrangement unless they had designed and installed the system as they could not guarantee the quality of that process.

SECTION 7

METERING AND BILLING

7 METERING AND BILLING

7.1.1 This section provides a detailed overview of the two key regulatory developments affecting heat networks; The *Heat Network (Metering and Billing) Regulations 2014* and a voluntary regulation scheme for heat network consumers offered by the *Heat Trust*.

7.2 Heat Network (Metering and Billing) Regulations 2014

7.2.1 The HNMB regulations transpose the requirements of Articles 9, 10 and 11 of the Energy Efficiency Directive (EED) into UK Law.

7.2.2 The regulations came into effect on 18th December 2014, with two key long stop dates for compliance with the following provisions:

- A duty to notify the enforcement body by 31st December 2015.
- A duty to install building level metering from the date the enforcement regulations came into effect on 18th December 2014.
- A duty to install final customer meters, or TRVs and heat cost allocators by 31st December 2016, where it is determined to be technical and economically viable.

7.2.3 This section provides additional detail on these requirements and on the requirements for new buildings, refurbishment and billing of consumers.

Duty to notify

7.2.4 Heat suppliers must notify the enforcement authority (being the National Measurement & Regulation Office) of each district heat network or communal heating system. The notification must include the following details:

- System capacity
- Number and type of buildings supplied
- Number and type of meters installed
- Number of customers
- Results of any analysis into cost-effectiveness/technical feasibility carried out
- Details of the billing information provided to customers.

7.2.5 The deadline for notification of existing systems, previously 30th April 2015, has been extended to 31 December 2015. For new systems completed after that date, the information must be notified on or before the date it commences operation. In addition the enforcement authority must be updated with the scheme details every four years, after first notification.

7.2.6 Notification templates are available from https://www.gov.uk/heat-networks.

Duty to install meters or heat cost allocators, TRVs and hot water meters

All Buildings

7.2.7 From 18 December 2014, existing district heat networks supplying a building occupied by more than one customer **must have building level meters installed** to measure the supply.

7.2.8 This does not apply to a single energy centre supplying a single building (see Existing Buildings below for guidance).

Single Occupier Buildings

7.2.9 Where there is a single occupier, then an individual meter must be installed to measure consumption by that customer (provided it is cost effective and technically feasible).

New Buildings

7.2.10 There is also the requirement to install meters for each individual customer where a newly constructed building is connected to a district heat network, or where a building supplied by a district heat network undergoes major renovations. These obligations should be considered as part of (re)development or major capital works programmes.

Existing Buildings

7.2.11 By 31 December 2016, each district heat network or communal heating system that supplies a building with more than one customer must have meters to measure each customer's consumption provided it is **cost effective and technically feasible**.

Heat Cost Allocators, TRVs and Hot Water Meters

7.2.12 Where determined that it is not cost effective or technically feasible to install meters the supplier must install heat cost allocators, thermostatic radiator valves, and a hot water meter, provided that this too is cost effective and technically feasible. Where this is not the case the supplier may employ alternative methods for determining charges using meters measuring the consumption of the whole block.

Cost Effective and Technically Feasible

7.2.13 The determination of whether the installation of either approach is cost effective or technically feasible must be carried out every four years and include details within the information notified to the NMRO.

7.2.14 The determination of feasibility examines the building characteristics, projected energy savings and wider costs of installation. Where the net present value of the projected energy savings to all final customers, over a 10 year period after the installation of the meters, is greater than the net present value of the cost of installing the meters it will be considered cost effective to install the meters.

7.2.15 Schedule 1 one of the regulations provides more detail and DECC have developed a tool to be used for undertaking the assessment.

Meter Accuracy

7.2.16 Where a meter is fitted it must accurately measure, memorise and display the consumption by the final customer. Although a fitted meter is required to be of a suitable quality and performance, the regulations do not set any specific technical parameters for its accuracy and quality.

7.2.17 The normal route for approval of design of a meter is through the Measuring Instruments Directive (MID). Where the installed meter has been approved under the MID, and the error limits in the MID are being applied, the enforcement authority will generally accept this route for approval of the meter. Where a meter is not approved under the MID, the authority may need to take a risk based approach to seeking further assurances of the meter's ability to meet the on-going accuracy requirements of the regulations.

Replacement of existing meters

7.2.18 Where an existing meter which is part of a district heating network or communal network is replaced the supplier must ensure that it satisfies the requirements of the regulations. This does not apply where it would be technically impossible or the estimated cost would be unreasonable.

Connection of new buildings and renovations

7.2.19 Where a newly constructed building is connected to a district heating network or a building undergoes major renovations which relate the technical services of that building the supplier must install sufficient meters to measure consumption by each final customer.

On-going Obligations

7.2.20 Meters or heat cost allocators to which the HNMB regulations apply must so far a possible ensure the meters are continuously operating and properly maintained and periodically checked for errors.

Billing

7.2.21 The following requirements are designed to cover all consumers and cover those who pay for heat on a credit basis. For consumers are supplied on a prepayment basis not all of these requirements will apply.

<u>Billing Requirements</u>

7.2.22 Heat suppliers must also ensure that billing information is accurate and based on actual consumption where a reading has been supplied by the customer or taken by the supplier.

7.2.23 A supplier need not comply with this unless it is technically possible and economically justifiable. The regulations state that the estimated reasonable cost does not exceed £70 per customer per year.

7.2.24 Where bills are based on meter readings to be provided by final customer but that customer has not provided a meter reading, a bill may be based on an estimate of consumption.

Billing Charges

7.2.25 There must not be a specific charge to a customer for the provision of a bill or billing information other than in respect of the supply of additional copies.

Billing Costs

7.2.26 The costs of providing bills and billing information in a building occupied by more than one final customer may be passed on provided that no profit is made from such charges. Where the task is carried out by a third party the reasonable costs of providing them may also be passed on.

Billing Information

7.2.27 Heat suppliers must provide billing information at the request of the customer, the bill must be clear and detail how it was calculated.

Enforcement

7.2.28 The regulations are enforced on behalf of the Secretary of State by the National Measurement Regulation Office (NMRO). It is an offence for any heat supplier to fail to comply with the regulations; however no person may be prosecuted in respect of any failure to comply which occurred before 31st December 2015.

7.2.29 The NMRO's enforcement approach is based upon their standard enforcement model, balancing intelligence and risk to enforce compliance with the regulations. This means that they will focus their efforts on schemes and operators deemed to be the most at risk of non-compliance. In the early phase of the scheme they are focused on affecting behaviours through non-directed intervention (i.e. education), moving to active support, and finally direct intervention (i.e. sanctioning).

7.2.30 At present after the no-directed intervention phase their enforcement actions are proportionate to the level of engagement and non-compliance by the scheme operator, the escalation of actions is as follows:

- Informal Warning
- Enforcement Undertaking
- Compliance Notice
- Non-compliance Penalty

- Formal Caution
- Court Action (if convicted a fine is imposed).
- Publicity

Summary

7.2.31 The key actions and timeline is summarised below:

Now

- Start preparing detailed information on each communal / district energy scheme.
- Comply with duty to install building level heat meters where more than one final customer is charged for the heat supplied.
- Viability assessments must be carried out for single occupancy buildings and buildings with more than once final customer to assess if individual heat meters; or (where meters are not viable) for heat cost allocators with hot water meters. These assessments and, where viable, any resulting installations must be completed by 31 December 2016.
- Connections to a newly constructed building or where a major renovation of building on a district heating network, meters must be fitted.

31st December 2015

- Register all schemes with NMRO.

31st December 2016

- Complete installation of meters for each final customer (where required)

2019

- Repeat the notification process with four years of the previous submission date.

7.2.32 Finally Secretary of State is obliged to review the operation and effect of these Regulations and publish a report within five years of them coming into force.

7.3 Heat Trust

Introduction

7.3.1 Heat Trust was formally established in March 2015 after two years of collaboration between industry, consumer groups and government. The Scheme will be run by an independent and impartial steering committee and will begin taking applications soon. Heat Trust establishes a common standard in the quality and level of protection given by heat supply contracts and offers heat network customers an independent process for settling disputes.

7.3.2 As of September 2015 the Heat Trust has not been formally launched, however they are welcoming expressions of interest at info@heattrust.org.

7.3.3 Heat Trust protection is aimed at heat energy suppliers who contract with metered or unmetered domestic and small businesses where the heat customer pays their supplier directly for their heat energy. Although voluntary, the Scheme is supported by government, industry and consumer groups as an industry led, self-regulation initiative that recognises best practice.

7.3.4 Once the scheme is established it is likely that the scheme will become "less voluntary" as schemes are actively encouraged to join and that joining the scheme may be a condition of a future grant, loan or scheme.

7.3.5 The Scheme sets out a number of provisions related to heat supplier obligations and service standards. These requirements are comparable to the quality and performance standards for regulated utilities and draw on legislation and industry best practice. As members of the Scheme, suppliers agree to abide by the Scheme Rules.

Joining the Heat Trust Scheme

7.3.6 The scheme markets the benefits of membership as helping to build customer knowledge of heat networks and build consumer and investor confidence. The provision of an Independent Complaints Handling service is a key aspect of the Heat Trust.

7.3.7 Once formally launched scheme operators join by filling out an application form detailing the particulars of the scheme, declaring that the scheme complies with scheme rule, guidelines and by-laws. Once submitted the application is reviewed and if accepted a participation offer is made, after accepting the offer the scheme will be listed on the Heat Trust website and will then have the right to use Heat Trust mark in consumer communications.

7.3.8 As of August 2015 there is a one off site registration fee of £80 and an annual fee per connection of £4.50.

Scheme Rules

7.3.9 The Scheme Rules have not been formally published as of September 2015. This section presents a summary based on the consultation proposals. The proposals set terms for supplier obligations and service standards and aim to be follow best practice, legal obligations (i.e. Heat Metering and Billing Regulations) and be comparable to the quality and performance standards for regulated utilities

7.3.10 The following table provides a summary of the proposed scheme rules from the consultation.

Table 7-1: Heat Trust Scheme Rules (Consultation Summary)

Category	Rule
Heat customer obligations	The Customer Heat Supply Arrangement and supporting documents are set out in a clear and understandable way.
Support for vulnerable heat customers	Support includes procedures to identify and register vulnerable customers, work with relevant support organisations, staff awareness, and no disconnection in winter. Vulnerable is defined in line with Ofgem's Consumer Vulnerability Strategy.
Heat supplier obligations	Ensure that heat energy supplied to a consumer exceeds the minimum level required at designed external air temperature. 24/7/365 supply. Where performance standards are not met, guaranteed service level payments will be due. • Unplanned interruption - £30 for each full 24 hour period (from hour 24) • Planned interruption – where longer than 5 working days - £30 for each full 24 hour period (from hour 24) • Multiple interruptions – four or more unplanned interruptions in an 12 month period and each unplanned interruption lasts more than 12 hours – one off payment £54 • Vulnerable customers – failure to make provision to maintain heat and hot water service where the interruption to supply planned or unplanned, lasts longer than 12 hours – £24
Heat customer service and reporting a fault or emergency	Customer service reporting via phone / email. Ability to report faults 24/7. Fault response times, 7 days when supply not interrupted, 48 hours out of heating season and 24 hours in heating season. Emergency response time 4 hours within and outside working hours..
Joining and leaving procedures	Clear joining and leaving procedures and maintain prospective heat customer information pack.
Heat meters	There are a number of requirements related to heat meters which seek to ensure that sites where meters are applicable are in compliance with both EU and UK legislation. The requirements cover; visibility of consumption by occupant, reading of meters, prepayment meters, inspection (every 2 years), and maintenance.
Heat Interface Units	The consumer must provide access the supplier to inspect and carry out any routine maintenance. This should be inspected every two years.
Heat bill and heat charge calculations	Billing information must be made available at least quarterly where based on actual consumption. At a minimum sites must include on the bill: • Heat energy supply charges (including unit price, variable charges, fixed charges and VAT) • The amount of heat energy consumed in the last 12 months, expressed in kWh • The total charges made over 12 months • Comparisons of the heat customers current energy consumption with consumption for the same period in the previous year Sites must ensure that as a minimum the fixed charges and VAT is the same for all heat customers whether on a prepayment or standard meter. Registered Sites may vary the unit price of heat energy supplied to a heat customer connected to a prepayment meter. Registered Sites must ensure that a heat customer's heat bill and/or annual statement specify all heat charges. These are likely to include; variable charges, heat used, price of that heat, fixed charges, and VAT. A Site must clearly set out how the charges have been calculated.
Heat bill payment	Sites are required to communicate to heat customers in a clear and understandable way

arrangements and the management of arrears	how to pay their heat bill. The Scheme sets out requirements for both credit customers and pre-payment customers. The Scheme also contains clauses related to refunds, back billing and non-payment.
Suspension and resumptions of service processes	The Scheme requires sites to clearly set out to heat customers their suspension and resumption of service processes.
Complaint handling and independent complaint handling	The Scheme sets out requirements for sites' internal complaint handling procedures which sites must adopt the following definition of a complaint: *"any expression of dissatisfaction made to an organisation, related to any one or more of its products, its services or the manner in which it has dealt with any such expression of dissatisfaction, where a response is either provided by or on behalf of that organisation at the point at which contact is made or a response is explicitly or implicitly required or expected to be provided thereafter".* Sites must set out a clear and easily accessible complaints and dispute resolution process. As a minimum Registered Sites must set out: • How to contact a Registered Site with a query or complaint • The information required from the heat customer to register and process a complaint • The steps a Registered Site will take to resolve a heat customer's complaint • The different remedies that may be available to a heat customer • The steps a heat customer can take if they are unable to reach a resolution with the site. • Details of actions a heat customer can take if they are unable to reach a resolution with their heat supplier (i.e. third party dispute resolution processes). The Scheme makes provision for an Independent Complaint Handling Mechanism that is available to heat customers of Registered Sites. The Independent Complaint Handling Service will be set up with the intention of providing a means of complaint resolution that is cheaper, faster and more effective than court action. A heat customer will become eligible to access the Independent Complaint Handling Mechanism once they have exhausted a Registered Site's internal complaint handling procedure. The Independent Complaint Handling Mechanism will be provided by the Ombudsman Service who provide expertise in dealing with customer complaints and operate the Energy Ombudsman. The Ombudsman Service also has employees that are expertly trained to deal with complaints concerning district heating.
Monitoring	The Scheme contains a requirement for sites to report key statistics back to the Scheme. As a minimum this will include: • Number of customers who fail to pay their bill by the due date • Number of service suspensions – Number of complaints received, by type; technical issues, metering, billing and charges, and customer service • Number of complaints resolved • Timescales of complaints resolved • Number of deadlock letter issued • Number of unplanned heat supply interruptions • Number of planned heat supply interruptions The Scheme will publish an annual report. All customer data will be anonymised, with Registered Site data only being anonymised upon request.
Privacy policy and data protection	Sites must comply with their obligations under the Data Protection Act 1998 in the collection and processing of the personal data of heat customers.

7.4 Metering and billing options

7.4.1 Sections 7.2 and 7.3 set out the latest legal developments with regard to metering and billing and also the measures being proposed by *Heat Trust*. All metering and billing for the New Cross heat network must follow the requirements for the 2014 *Heat Network Regulations*.

7.4.2 The regulations do not distinguish between domestic and non-domestic customers; rather they specify the requirement for metering at different points of demarcation. They do refer to individual customers within multiple occupancy buildings, which would be domestic customers in most cases but could also refer to offices with multiple tenants.

7.4.3 With regard to the management of metering and billing, the decision on how to do this is based around the level of involvement the system operator wishes to retain and the level of automation desired. For the purposes of a New Cross Heat Network, it is proposed that heat would be sold to connected buildings at a single point of demarcation within the customer plant room. The sale of heat on to domestic customers in, for example, Batavia Road, would be the legal responsibility of the building operator. This is discussed in Sections 4.6 and 4.8.

Data Collection

7.4.4 There are various options for the collection of heat consumption data. The heat substation at each consumer will be fitted with a heat meter, which calculates heat consumed to each customer based on the flow rate and temperature differential between the flow and return pipework, which gives a measure of the heat transferred to the customer system.

7.4.5 On a DH network, each heat substation is connected to the primary control system (PCS) at the heat source via a fibre optic communications cable (buried along with the DH pipe in a duct). The fibre optic cable is there to allow active communication between the heat source and the heat substation, for example it communicates when there is heat available at the heat source and enables the substation to start working or shut down on that basis.

7.4.6 The substation also transmits ‘read only’ information, such as heat consumption, to the PCS. One option, therefore, is for the heat consumption information to be taken in bulk from the primary control system at the heat source (in this case, SELCHP). Readings can be recorded manually at the PCS outstation, provided via a modem or viewed over the internet.

7.4.7 Alternatively, readings can be taken directly from each connected customer. At the most basic level, this can be recorded manually, either by someone at the heat customer or by dedicated personnel working for the heat network operator. Alternatively additional communications hardware can be installed to collect heat meter data. This can be either by:

- Wired network connection; or

- Low power radio transmitter, allowing a signal to be transmitted and received within a short distance allowing data collection from outside the plant room. This approach means a person would need to drive around the customer connections taking readings; or
- A GSM modem can be used to transmit data.

7.4.8 It may be the case that different approaches are used for data collection at different customers across the network due to e.g. access issues or the ability of radio signals to penetrate into plant rooms.

Billing

7.4.9 Once readings have been taken, either in person, over the internet or via a phone line (modem), heat meter readings will need to be verified, customer billed and payment collected / monitored. Some parties, such as a local authority, may already be set up to undertake these duties, for example if they have existing metering and billing services for local authority housing stock.

7.4.10 If the network operator does not want to be responsible for metering and billing a third party company can be engaged to undertake these duties. These organisations collect data either through existing systems (if available) or install communications hardware to collect heat meter data and manage the billing and payment process.

Summary

7.4.11 The preferred metering and billing approach for a New Cross Heat Network depends on who delivers and operates the scheme. If Veolia/SELCHP are the sole operator, they are likely to outsource the metering and billing to a third party, who they may already partner with on other schemes.

7.4.12 If LBL are involved, there may be an opportunity to extend existing services to include customers to the New Cross Heat Network; however it is not possible to comment on this further without knowing more about LBL's current operations.

SECTION 8

SWOT ANALYSIS

8 SWOT ANALYSIS

8.1.1 We have undertaken an analysis of Strengths, Weaknesses, Opportunities and Threats for the project. The SWOT analysis is presented on the following page.

State Project Objective: Delivery of low carbon heat network from SELCHP to Goldsmiths	
Strengths (internal factors)	**Weaknesses (internal factors)**
Economic Public sector typically has better access to funding than private sector Public sector may be able to take a longer term view with regard to economic performance	Gaps in knowledge and expertise LBL does not have experience in delivering wide area DH network infrastructure or of procuring partners to do so
Resource availability Potential for operational engagement via existing M&E team and metering and billing services. Existing heat source – SELCHP	Timescale and deadlines Length of processes of evaluation and approval in the public sector (if project is led by LBL or Goldsmiths)
Skill levels Has powers to deliver heat and/or electricity sales in Borough Goldsmiths experience with heat networks across their campus	Budget No current budget for delivery of these schemes – funding may be available
Processes and systems Planning team can seek to require developers to connect, improving the economics	Competing projects SELCHP are selling opportunity to other developers – e.g. Convoys Wharf and heat available is limited
Reputation Public sector involvement brings confidence in the scheme's value and resilience	Processes and systems Key roles in delivery of project would require new processes to be developed
Opportunities (external factors)	**Threats (external factors)**
Technology and infrastructure development Project could deliver/enable: • low carbon development • increased energy network resilience through increased diversity of supply • fuel poverty reductions • reduced energy cost volatility • improved process efficiency at SELCHP through utilisation of waste heat	Political influences LBL politicians may change during development period and priorities may change LBL priorities may change after development and starve scheme of funding to maintain/develop RHI benefit to SELCHP may be reduced/removed Policy changes at local, regional or national level could undermine the case for the network
Changing energy consumption efficiency Encouraging/requiring efficient secondary system design Changing consumer behaviour	Environmental factors Potential contaminated land and unexploded ordnance Anticipated changes in climate patterns may reduce heat demand and there may be an increased demand for cooling Changing consumer behaviour could lead to a

	reduction in demand for heating
Emerging and developing markets Other connection opportunities exist and network could enable multiple additional connections	External activity Feasibility relies on other utilities not installing apparatus along the preferred route between now and installation Preferred route requires Wayleave for British Wharf land on Surrey Canal Road
Market demand London Plan requirements would make connection nearly compulsory for new developments	Economy Developer market may disappear if there is a further recession Connections & Pricing Heat price may be set at a level that is not financially viable for Goldsmiths and others Lack of heat market regulation and the focus upon development of voluntary standards potentially leaves heat customers exposed

SECTION 9

APPENDICES

9 APPENDICES

9.1 Appendix A – Detailed capital cost breakdown

9.1.1 A detailed breakdown of costs included in the modelling is presented in the following table. All items are modelled as occurring in 2017 with the exception of those listed in the table below the capex breakdown.

Item	Peak load cost	Base load cost	Future-proofed	Year	Notes
Packaged distribution pump set	£130,000	£100,000	£130,000	2017	Based on contractor prices from a recent project. Packaged pump skid: 2 x 11kW units and a jockey pump. Reduced for baseload system.
Sidestream filter	£20,000	£20,000	£20,000	2017	Based on contractor prices from a recent project
Degasser	£25,000	£25,000	£25,000	2017	Based on contractor prices from a recent project
Duplex filter	£50,000	£40,000	£50,000	2017	Based on contractor prices from a recent project
Expansion and pressurisation	£150,000	£130,000	£150,000	2017	Based on contractor prices from a recent project for a 220m3 system
Energy meters	£20,000	£20,000	£20,000	2017	Based on contractor prices from a recent project
Pipework within SELCHP	£150,000	£150,000	£150,000	2017	Estimate
Insulation	£10,000	£10,000	£10,000	2017	Estimate
Controls system	£200,000	£200,000	£200,000	2017	Estimate
Builder's work in connection	£25,000	£25,000	£25,000	2017	Estimate
SELCHP additional plant design	£39,000	£36,000	£39,000	2017	Assumed 5% of total plant and install cost
Preliminary site investigations for DH network (trial holes)	£50,000	£50,000	£50,000	2017	Estimate
Core DH network	£1,857,262	£1,710,191	£2,595,849	Split	Based on contractor guide prices issued for this project. Includes all pipework, isolation valves, alarm wires, prelims, design etc. Does not include DH alarm system.
Core DH network design	£15,000	£15,000	£15,000	2017	Estimate
DH system alarm	£10,000	£10,000	£10,000	2017	Estimate
Allowance for landscaping and bespoke reinstatement	£100,000	£100,000	£100,000	2017	Estimate
Landscaping design	£12,500	£12,500	£12,500	2017	Based on 12.5% of landscaping costs
Heat substations	£447,386	£235,906	£447,386	Split	Includes supply, install, craneage, internal pipework, power supply, fire protection. Based on contractor prices for a recent project
Substation design	£22,369	£11,795	£22,369	2017	Assumed 5% of total plant and install cost
Contract admin / client engineer fees	£100,000	£100,000	£100,000	2017	Estimate
Contingency	£686,704	£600,278	£834,421	2017	Based on 20% of overall project cost
Total	**£4,120,221**	**£3,601,670**	**£5,006,526**		

Year	Items included in capex
2017	All items in capex list except those listed below for 2018 and 2019
2018	Substations at Goldsmiths, Batavia & Childeric primary DH pipe to Goldsmiths, Batavia & Childeric primary plant rooms
2019	Substations at Goodwood Road & Bond House developments DH pipe to Goodwood Road & Bond House development plant rooms

9.2 Appendix B – Cash flow through time (25 years)

Base load

Item	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
Capex (£k)	£3,245.2	£228.6	£127.8	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0
Heat from SELCHP (£k)	£0.0	£45.5	£55.0	£59.4	£63.6	£67.2	£70.3	£72.8	£75.0	£74.7	£73.9	£72.6	£77.5	£79.3	£79.4	£76.4	£72.6	£66.3	£61.0	£61.0	£61.0	£61.0	£61.0	£61.0	£61.0	£61.0
Electricity for parasitics (£k)	£0.0	£15.1	£16.3	£16.5	£17.3	£17.7	£18.3	£18.9	£19.5	£19.8	£19.6	£19.6	£20.0	£20.0	£20.3	£20.1	£19.5	£18.9	£18.6	£18.6	£18.6	£18.6	£18.6	£18.6	£18.6	£18.6
Network maintenance (£k)	£0.0	£34.2	£34.2	£34.2	£34.2	£34.2	£34.2	£34.2	£34.2	£34.2	£34.2	£34.2	£34.2	£34.2	£34.2	£34.2	£34.2	£34.2	£34.2	£34.2	£34.2	£34.2	£34.2	£34.2	£34.2	£34.2
Avoided Goldsmiths CRC (£k)	£0.0	£13.8	£14.2	£14.6	£15.0	£15.5	£15.9	£16.4	£16.9	£17.4	£17.9	£18.5	£19.0	£19.6	£19.6	£19.6	£19.6	£19.6	£19.6	£19.6	£19.6	£19.6	£19.6	£19.6	£19.6	£19.6
Unit heat sales to customers (£k)	£0.0	£109.1	£137.1	£142.0	£146.0	£150.0	£153.9	£157.9	£161.9	£163.3	£164.7	£166.0	£167.7	£169.9	£169.8	£169.8	£169.8	£169.8	£169.8	£169.8	£169.8	£169.8	£169.8	£169.8	£169.8	£169.8
Fixed rate contribution (£k)	£0.0	£33.4	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8
Total annual operating cost (£k)	**-£3,245.2**	**-£167.3**	**-£41.3**	**£87.3**	**£86.8**	**£87.2**	**£87.8**	**£89.2**	**£90.8**	**£92.7**	**£95.8**	**£98.9**	**£95.8**	**£96.8**	**£96.4**	**£99.5**	**£103.9**	**£110.8**	**£116.4**	**£116.4**	**£116.4**	**£116.4**	**£116.4**	**£116.4**	**£116.4**	**£116.4**
NPV @ 3.5%	**-£1,991.6**																									

Peak load

Item	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
Capex (£k)	£3,551.0	£356.1	£213.1	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0
Heat from SELCHP (£k)	£0.0	£50.6	£61.4	£66.3	£70.9	£74.9	£78.4	£81.2	£83.7	£83.3	£82.4	£81.0	£86.5	£88.5	£88.5	£85.2	£81.0	£73.9	£68.0	£68.0	£68.0	£68.0	£68.0	£68.0	£68.0	£68.0
Electricity for parasitics (£k)	£0.0	£16.2	£18.2	£18.3	£19.2	£19.7	£20.4	£21.1	£21.7	£22.1	£21.8	£21.8	£22.3	£22.3	£22.6	£22.4	£21.7	£21.1	£20.7	£20.7	£20.7	£20.7	£20.7	£20.7	£20.7	£20.7
Network maintenance (£k)	£0.0	£37.1	£37.1	£37.1	£37.1	£37.1	£37.1	£37.1	£37.1	£37.1	£37.1	£37.1	£37.1	£37.1	£37.1	£37.1	£37.1	£37.1	£37.1	£37.1	£37.1	£37.1	£37.1	£37.1	£37.1	£37.1
Avoided Goldsmiths CRC (£k)	£0.0	£15.3	£15.8	£16.3	£16.8	£17.3	£17.8	£18.3	£18.9	£19.4	£20.0	£20.6	£21.2	£21.9	£21.9	£21.9	£21.9	£21.9	£21.9	£21.9	£21.9	£21.9	£21.9	£21.9	£21.9	£21.9
Unit heat sales to customers (£k)	£0.0	£121.3	£152.9	£158.4	£162.8	£167.2	£171.6	£176.1	£180.5	£182.1	£183.7	£185.1	£187.1	£189.5	£189.4	£189.4	£189.4	£189.4	£189.4	£189.4	£189.4	£189.4	£189.4	£189.4	£189.4	£189.4
Fixed rate contribution (£k)	£0.0	£33.4	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8
Total annual operating cost (£k)	**-£3,551.0**	**-£290.1**	**-£120.2**	**£93.7**	**£93.1**	**£93.6**	**£94.3**	**£95.8**	**£97.6**	**£99.7**	**£103.2**	**£106.6**	**£103.2**	**£104.3**	**£103.8**	**£107.3**	**£112.2**	**£119.9**	**£126.1**	**£126.1**	**£126.1**	**£126.1**	**£126.1**	**£126.1**	**£126.1**	**£126.1**
NPV @ 3.5%	**-£2,376.0**																									

Future-proofed

Item	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
Capex (£k)	£4,437.3	£356.1	£213.1	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0
Heat from SELCHP (£k)	£0.0	£51.9	£63.0	£68.0	£72.8	£76.9	£80.4	£83.3	£85.9	£85.5	£84.5	£83.1	£88.7	£90.8	£90.8	£87.4	£83.1	£75.8	£69.8	£69.8	£69.8	£69.8	£69.8	£69.8	£69.8	£69.8
Electricity for parasitics (£k)	£0.0	£16.2	£18.2	£18.4	£19.3	£19.7	£20.5	£21.1	£21.8	£22.2	£21.8	£21.8	£22.3	£22.3	£22.6	£22.5	£21.8	£21.2	£20.8	£20.8	£20.8	£20.8	£20.8	£20.8	£20.8	£20.8
Network maintenance (£k)	£0.0	£51.9	£51.9	£51.9	£51.9	£51.9	£51.9	£51.9	£51.9	£51.9	£51.9	£51.9	£51.9	£51.9	£51.9	£51.9	£51.9	£51.9	£51.9	£51.9	£51.9	£51.9	£51.9	£51.9	£51.9	£51.9
Avoided Goldsmiths CRC (£k)	£0.0	£15.3	£15.8	£16.3	£16.8	£17.3	£17.8	£18.3	£18.9	£19.4	£20.0	£20.6	£21.2	£21.9	£21.9	£21.9	£21.9	£21.9	£21.9	£21.9	£21.9	£21.9	£21.9	£21.9	£21.9	£21.9
Unit heat sales to customers (£k)	£0.0	£121.3	£152.9	£158.4	£162.8	£167.2	£171.6	£176.1	£180.5	£182.1	£183.7	£185.1	£187.1	£189.5	£189.4	£189.4	£189.4	£189.4	£189.4	£189.4	£189.4	£189.4	£189.4	£189.4	£189.4	£189.4
Fixed rate contribution (£k)	£0.0	£33.4	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8	£40.8
Total annual operating cost (£k)	**-£4,437.3**	**-£306.3**	**-£136.7**	**£77.1**	**£76.4**	**£76.8**	**£77.4**	**£78.8**	**£80.6**	**£82.7**	**£86.2**	**£89.6**	**£86.1**	**£87.1**	**£86.6**	**£90.2**	**£95.2**	**£103.1**	**£109.5**	**£109.5**	**£109.5**	**£109.5**	**£109.5**	**£109.5**	**£109.5**	**£109.5**
NPV @ 3.5%	**-£3,538.9**																									

9.3 Appendix C – Unit prices used in economic modelling

Item	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
Cost of heat from SELCHP through time (p/kWh)	0.97	0.96	1.04	1.11	1.17	1.23	1.27	1.31	1.30	1.29	1.27	1.35	1.38	1.38	1.33	1.27	1.16	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06
Electricity import price through time (p/kWh)	10.39	11.63	11.75	12.31	12.60	13.09	13.50	13.90	14.16	13.96	13.95	14.27	14.27	14.47	14.36	13.92	13.52	13.26	13.26	13.26	13.26	13.26	13.26	13.26	13.26
Goldsmiths unit heat price through time (p/kWh)	2.39	2.37	2.45	2.52	2.59	2.66	2.73	2.80	2.82	2.85	2.87	2.90	2.94	2.93	2.93	2.93	2.93	2.93	2.93	2.93	2.93	2.93	2.93	2.93	2.93

9.4 Appendix D – Contractor pipe prices

9.4.1 The following prices include all design, prelims, OH&P, site set-up, and project management costs. For total installed cost, add the pipe cost in column 2 to one of the civils costs in the last four columns for the appropriate diameter pipe.

Pipe size (mm)	Pipe cost per metre (flow and return)	Hard dig (mechanical) cost per metre	Hard dig (hand) cost per metre	Soft dig (mechanical) cost per metre	Soft dig (hand) cost per metre
50	£286	£320	£620	£149	£249
65	£298	£320	£620	£149	£249
80	£312	£320	£620	£149	£249
100	£392	£328	£633	£156	£263
125	£436	£344	£647	£164	£278
150	£454	£344	£647	£164	£278
200	£550	£378	£686	£172	£281
250	£702	£412	£892	£179	£367
300	£860	£478	£977	£190	£421
350	£1,120	£582	£1,094	£217	£460