Berkeley Homes (Oxford & Chiltern) Ltd.

Vastern Road

Energy Strategy: Response to Element Energy

Final V3

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ABOUT HODKINSON CONSULTANCY

Our team of technical specialists offer advanced levels of expertise and experience to our clients. We have a wide experience of the construction and development industry and tailor teams to suit each individual project.

We are able to advise at all stages of projects from planning applications to handover.

Our emphasis is to provide innovative and cost-effective solutions that respond to increasing demands for quality and construction efficiency.

CONTENTS

1. INTRODUCTION

1.1 This report has been prepared by Hodkinson Consultancy, a specialist energy and environmental consultancy for planning and development.

1.2 Hodkinson Consultancy have been appointed by Berkeley Homes (Oxford & Chiltern) Ltd to prepare a formal response to Element Energy's critical review of the proposed Vastern Road energy strategy (dated June 2020). The strategy was originally proposed in the Energy Statement (December 2019) submitted as part of the planning application to Reading Borough Council (RBC).

1.3 The development proposes to provide 209 dwellings, with the site located between Vastern Road to the south and the River Thames to the north. This is shown in Figure 1, below.

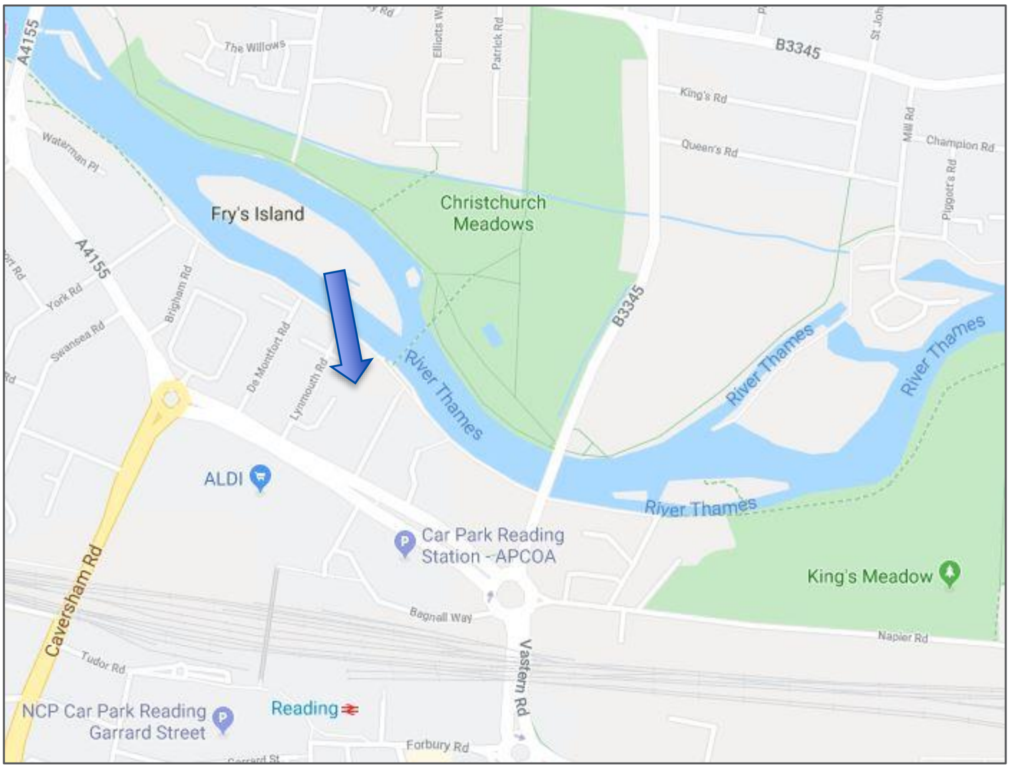

Figure 1: Site Location ***(Source: Imagery @ 2020 Google, Map data ©2020 Google)***

Summary of Proposed Energy Strategy

1.4 The energy strategy put forward as part of the Energy Statement can be summarised as follows:

> Enhanced fabric elements for glazing, floors, walls, and roofs which go over and beyond those required by Part L (2013). This includes a bespoke approach to construction detailing to minimise the impact of thermal bridges;

> MVHR systems in all blocks except for A, which will have cMEV systems;

> Direct electric panel heaters for space heating, with an immersion cylinder for hot water;

> 70kWp of solar photovoltaics (PV) installed on the most appropriate roof spaces.

1.5 The proposed strategy achieves both the current Part L 2013 metrics (TFEE and TER) under SAP 2012 carbon factors and exceeds the 35% CO_2 reduction target under Policy H5c of the RBC Local Plan using SAP 10.1 carbon factors.

1.6 The remainder of the report will address each of the key points which were raised by Element Energy within their report. Section 2 will present a cost analysis of communal heat pump-led systems, inclusive of ASHP, GSHP and WSHP scenarios.

1.7 A feasibility appraisal on the following heat pump-led networks will be outlined in Section 3:

> Communal closed-loop GSHP system;

> Communal open-loop GSHP system;

> Communal WSHP system.

1.8 Section 4 will address the remaining Element Energy points related to PVs, MVHR and RBC's plans for a wider area heating network.

2. COST ANALYSIS – PROPOSED HEATING STRATEGY VS HEAT PUMP SOLUTIONS

2.1 Section 2 examines the heating costs to residents under the proposed direct electric strategy and how this differs to a series of heat pump-led communal heating networks.

2.2 Heat charges to residents are commonly structured from the following costs:

> Maintenance (both planned and reactive);

> Meter reading, billing, and customer services;

> Collection of a capital replacement fund;

> Other related management costs (e.g. insurances, consultant fees);

> Utilities (fuel standing charges and plant room electrical costs);

> Variable rate (i.e. the price of heat).

2.3 Often, most of these cost components will be collated and levied under an overall standing charge, with the variable rate used as the heat consumption charge.

2.4 For individual heating systems, certain costs such as the capital replacement fund and plant maintenance (of e.g. a boiler or a hot water cylinder) will not be reflected in the utility standing charges levied upon residents for their use of the gas or electricity grid. Nonetheless these are costs which should be accounted for in any cost comparison exercise to ensure any comparison is as fair as is reasonably possible.

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Summary of Heating Costs

2.5 The graph shown in Figure 2, below, shows all variable and fixed costs presented for each of the heating scenarios.

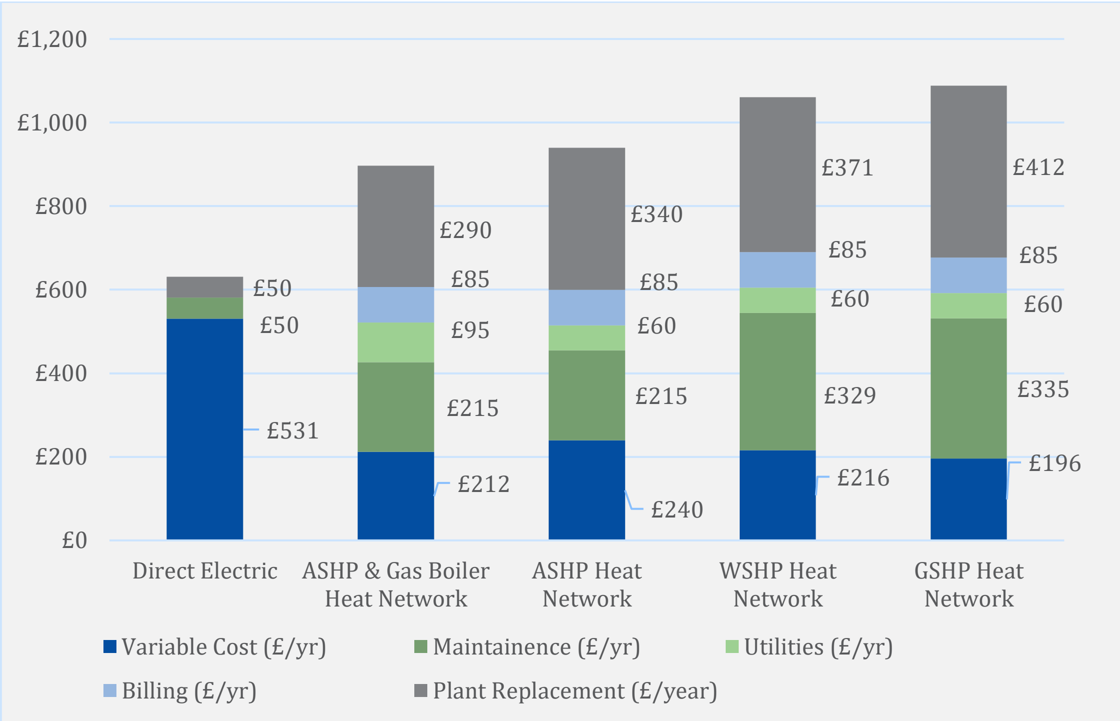


Figure 2 – Total Annual Costs

2.6 A summary of the total resident costs from lowest to highest is as follows:

> Individual – direct electric - **£631/yr**;

> Heat Network – heat pumps (air source) and gas boilers - **£897/yr** *(42% increase)*;

> Heat Network – heat pumps only (air source) - **£940/yr** *(49% increase)*;

> Heat Network – heat pumps only (water source) - **£1,061/yr** *(68% increase)*;

> Heat Network – heat pumps only (ground source) - **£1,088/yr** *(72% increase)*.

2.7 It should be noted that all costs for GSHP systems included in Section 2 are based on an open-loop set-up. A closed-loop system has been deemed to be unviable due to spatial constraints. This shall be explored further in Section 3.

2.8 It is shown that although heat consumption costs (variable) are lower for all heat network scenarios, the much higher fixed costs mean that overall residents are expected to be paying at least 40% more in heating costs than the proposed direct electric system. An open-loop GSHP could result in costs which are as much as 70% higher.

2.9 This analysis has been repeated for instances where the dwelling heating demands may be 50% higher or 50% lower than anticipated through SAP calculations, or where heat network losses would be much lower. These results are shown in Appendix B, and demonstrate that under each of these conditions direct electric heating still represents the most cost-effective system for residents.

2.10 No Renewable Heat Incentive payments have been assumed due to the risk that any plant will not be commissioned before March 2022.

Discussion of Cost Elements

Heat Consumption

2.11 Appendix A shows the calculated cost of heat consumption (both space heating and hot water) to residents at Vastern Road. Annual heat demands at the dwelling are the same in each scenario and are based on the fabric strategy proposed in the Energy Statement. For all communal heating scenarios additional heat demands on the network in the form of network losses between an Energy Centre and dwellings have been accounted for. A Distribution Loss Factor (DLF) of 1.5 has been assumed in each scenario to align with SAP 10.1 methodology. This allows for this factor in as built assessments which have been design and commissioned in accordance with the CIBSE/ADE Code of Practice document.

2.12 The calculated variable heat tariff for each scenario comes from the following formula:

((**Heating Demands at Energy Centre ÷ Plant Efficiency**) x **Price of Fuel**) ÷ **Heating Demands at Dwelling.**

Fixed Heating Costs

2.13 A breakdown of the fixed costs compiled for this analysis is shown in Appendix A. A summary discussion is provided below.

Billing & Customer Services

2.14 The operation of a heat network requires a centralised process for the collection of dwelling meter reads and issue of bills (usually monthly) in line with this information. This service is usually undertaken by a third-party specialist, who are employed by the network owner and provide a fixed cost which is to be split out between residents. Typically customer services, in the form of literature and a staffed phone line with out of hours services, is included within this package.

2.15 Hodkinson Consultancy have run a number of tendering exercises for the procurement of specialist heat network services in relation to maintenance and billing activities on behalf of various clients. As billing costs tend to be based on a per dwelling rate, there is not much variety when assessing the average per dwelling cost across a range of heat network sizes. Based on a number of tender returns for this service across several different developments, £85/yr is considered an average.

2.16 The equivalent service for the direct electric scenario would be covered within the electricity standing charge to the dwelling. As this would be applicable to heat network customers as well due to the use of electricity for other applications, it is not included in this assessment.

Utilities

2.17 Residents on heat networks will also be required to contribute to the cost of utilities associated with running the network. The price of fuel at an Energy Centre (p/kWh) is already accounted for within the calculated variable heat tariff, however other costs such as the fuel standing and capacity charges and ancillary electricity across the network (e.g. for pumps, pressurisation units, controls etc) will be charged back to residents in the fixed charges (either via the heating standing charge itself or in the wider service charges). The latter of these can be much higher than anticipated, and Hodkinson Consultancy have seen several developments exceed 500kWh/yr/dwelling for this ancillary electricity. A lower estimate of 250kWh/yr has been used in this assessment (£34/yr at the electricity import price of 13.5p). The electricity standing and capacity charges at the Energy Centre increase this to £60/yr.

2.18 The sole scenario which also has gas as part of its heating fuel has a higher estimated utility cost of £95/yr as a gas standing charge at the Energy Centre will also be factored in here.

Maintenance

2.19 All scenarios will incur costs associated with annual maintenance. The direct electric strategy has assumed a £50/yr cost to cover a cylinder check. Maintenance for panel heaters has not been included, just as radiators will not be included in the analysis for the other scenarios.

2.20 Maintenance costs on heat networks, particularly those of a relatively small size, tend to be high. Whilst dwelling maintenance (for HIUs and meters) is often charged on a per unit basis and thus does not vary greatly between development sizes, costs associated with plant room and network maintenance tend to increase quite significantly on a per dwelling basis for smaller sites. Central plant items and ancillary equipment will need to be tailored to the capacity requirements of the site, but these costs do not linearly track the number of customers on the network. Smaller sites such as Vastern Road therefore provide fewer customers for these costs to be divided up between.

2.21 Costs obtained by Hodkinson Consultancy for maintenance of WSHP & open-loop GSHP systems on currently operational developments shows these set-ups to be significantly higher than that of ASHP systems. Maintenance requirements for the heat pumps themselves and Energy Centre ancillary equipment as well as the above ground distribution network is required in all scenarios, however additional elements also need factoring in for WSHP and GSHP-led systems. These include maintenance of the heat exchangers (between the water sources and the network), filters and additional pump sets. Reporting and monitoring on behalf of the Environment Agency is also required. Although these costs are site specific, they are for sites which are not too dissimilar in scale to that of Vastern Road, and so are considered reflective.

2.22 Costs for the ASHP-led network have come from an average of recently ran tender exercises for similarly sized sites.

Capital Replacement

2.23 All scenarios will incur costs associated with the replacement of infrastructure items when they near the end of their operating lifespan. The direct electric strategy has assumed a £50/yr cost to cover the replacement of the immersion cylinder (£750 for a 15-year lifespan). Panel heaters have not been included, just as radiators will not be included in the analysis for the other scenarios.

2.24 For the heat network scenarios, the same difficulties related to high maintenance costs being borne by a relatively low number of customers again applies for plant replacement funds.

2.25 The same cost sources as those used in the compilation of maintenance costs have been used for continuity. Similarly, the additional infrastructure required on top of an ASHP-led system is the reason for the higher replacement costs.

3. GSHP & WSHP APPLICATION

3.1 Section 3 of this report provides an analysis of the GSHP and WSHP scenarios set out in Element Energy's report. As shown in Section 2, neither of these systems compare favourably with the proposed direct electric system on resident costs.

Heat Pump Sizing

3.2 An initial sizing exercise has been carried out to determine the plant requirements for all centralised heat pump options. This has concluded the following plant sizes are likely to be required, subject to detailed design development:

> Heat Pump Output: 365kW;

> Thermal Store requirement: 8,000 litres.

Closed-Loop GSHP

System description

3.3 Closed loop GSHP systems involve circulation of water and antifreeze mixture through a series of underground pipes. For relatively dense sites such as the proposed development at Vastern Road, vertical boreholes are likely to be the only feasible way of extracting sufficient heat due the excessive space required for horizontal ground loops.

3.4 The heat abstracted from the ground is transferred via a heat exchanger to a heat pump which upgrades heat from c12°C to a useful temperature.

3.5 A typical borehole will be capable of extractive approximately 3 – 5kW from a single 100m deep borehole, although this is highly dependent on local ground conditions. To ensure boreholes do not interact with each other or excessively cool the ground, a minimum spacing of approximately 8m between boreholes is recommended (again, dependent on site specific ground conditions).

3.6 Where multiple boreholes are required, these should be connected in such a way that heat extraction is evenly distributed across the array.

3.7 Due to the relatively stable temperatures of approximately 12°C available at a depth of 5m+, GSHPs offer higher efficiencies than air source heat pumps.

Source requirements

3.8 A site-specific thermal response test would be required as part of any detailed early stage feasibility works. This would determine the exact number of boreholes required, as well as their depth and spacing.

3.9 Initial rules of thumb suggest that between 50 and 80 boreholes would be required to deliver 365kW heat output from a ground source heat pump. This would result in a requirement for approximately 2,500 – 4,000m² land area based on an initial spacing exercise.

3.10 Element Energy noted in their report how a closed-loop GSHP system is likely to require an area which covers 3-4,500m² at Vastern Road, which was acknowledged as challenging given the spatial constraints of the site.

Technical feasibility

3.11 The high number of boreholes, trenching and overall space required for a closed loop GSHP system mean that this solution is not a possibility for a dense site such as Vastern Road. The total site area which has been deemed appropriate for the installation and ongoing access of boreholes is 1,939m². This is significantly lower than the lowest spatial requirements estimated by both Element Energy and Hodkinson Consultancy, and an 8m spacing between boreholes could not be achieved. A site plan showing the available area has been included in Appendix C.

3.12 The ground on and around the development also has a contamination risk, due to the site previously hosting a power station. This presents a further complication.

Open-Loop GSHP

System Description

3.13 An open loop GSHP extracts water from the aquifer through abstraction wells containing submersible pumps. Ground water is typically returned to the aquifer through a second reinjection well. For schemes not including cooling, systems are typically doublet systems, with abstraction and reinjection wells located approximately 100m apart to prevent thermal interaction or bypass.

3.14 The ground water extracted is generally run through an intermediate heat exchanger before heat is upgraded in the water source heat pump.

Source requirements

3.15 Based on a typical temperature differential of 10°C between the abstraction and reinjection boreholes, a flow rate of approximately 6l/s would be required from the aquifer.

3.16 There are no existing borehole records within the vicinity of the site at a depth of more than 30m available from the British Geological Survey website (Figure 3, below).

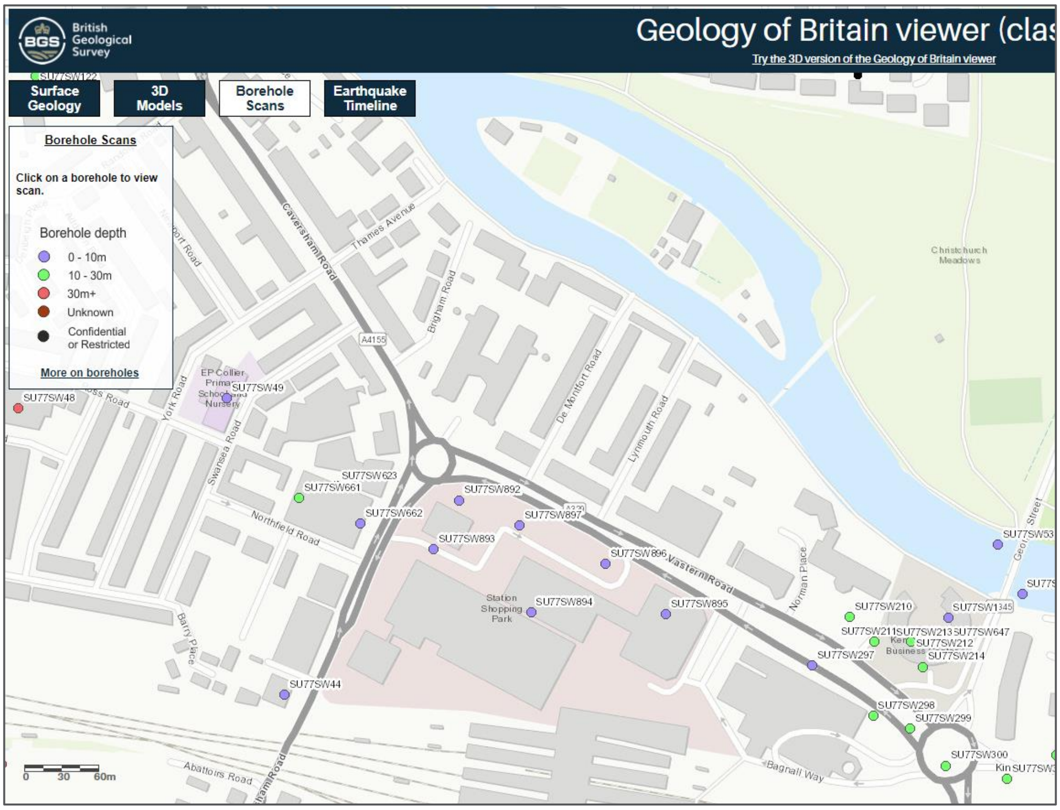


Figure 3: Borehole Data (http://mapapps.bgs.ac.uk/geologyofbritain/home.html)

3.17 In order to determine the suitability of the site for open-loop GSHPs, a detailed feasibility assessment would be required which would involve the drilling of test wells and close liaison with the Environment Agency. This would determine available heat yields, as well as data on water quality and therefore filter requirements, both of which can significantly impact capital and operational costs of such systems.

Technical feasibility

3.18 Open loop ground source systems do not encounter the same spatial constraints as closed loop systems due to the reduced ground area required for abstraction and reinjection wells compared to that of boreholes.

3.19 The equipment required to implement this solution will depend on water quality and yield available from the aquifer, but is likely to include 2No. wells, submersible pump, filtration equipment, sensors and controls and an intermediate heat exchanger, as well as the heat pump itself. This is likely to add significant costs (capital and operational) to the standard fixed costs of operating a heat network, as has been shown in Section 2.

3.20 As stated previously, the ground on and around the development also has a contamination risk due to the site previously hosting a power station.

3.21 The technical feasibility and requirements of an open-loop GSHP solution can only be determined following detailed investigation using site-specific test wells and ground contamination assessments. Work of this kind would be a significant capital outlay and build programme risk, and would only be worthwhile undertaking if an initial running cost assessment could show that such a solution can clearly deliver heat at an affordable rate to customers. As shown in Section 2, this is not the case. For this reason, an open-loop GHSP system cannot be proposed for Vastern Road.

Surface WSHP

System Description

3.22 Surface water source heat pumps operate on similar principles to open loop ground source, but extract water from surface water bodies. For the proposed development, the River Thames is the most likely heat source.

3.23 Typical surface water source heat pump solutions using river water have slightly lower efficiencies than ground water due to the seasonal variations in temperature, but can deliver higher efficiencies than air source heat pumps.

3.24 Typical equipment required for an open loop surface water heat pump includes extraction and discharge pipes linking a heat exchanger to primary filters located within the water source. Following primary filtration, water is drawn through secondary filters using abstraction pumps and heat is transferred to the secondary heat pump circuit using plate heat exchangers.

3.25 Monitoring equipment is also key to ensure water quality and temperatures fall within the regulatory body requirements.

Source requirements

3.26 Based on CIBSE recommended river water temperature differentials, a flow rate of approximately 20l/s would be required from the Thames.

3.27 Detailed surveys of the river at this location would be required before proceeding to determine flow rates, contours, and temperature profiles at different depths to ensure sufficient heat can be extracted without breaching temperature limitations set by the Environment Agency, the regulatory body responsible for the Thames.

3.28 Furthermore, once feasibility is confirmed, Environment Agency abstraction and discharge licences are likely to be required which will also determine ongoing monitoring and reporting requirements.

Technical feasibility

3.29 The design of the abstraction and reinjection system requires extensive survey and licence application work, therefore making this a build programme and capital outlay risk.

3.30 A WSHP-led network would also need to cross third-party land at Vastern Road to route abstraction and discharge pipes to the development from the river, providing a further difficulty which could potentially impact on the deliverability of the development.

3.31 As with open-loop GSHPs, the risks associated with proceeding with this system could only be determined as justifiable if it could be clearly shown that resident heating costs would be affordable. As outlined in Section 2, this is not the case at Vastern Road. For this reason, a WHSP system cannot be proposed.

4. REMAINING ENERGY STATEGY

4.1 Section 4 looks to respond to the remaining energy strategy items raised by Element Energy. These can be summarised as follows:

> Any RBC proposals for a wider area heating network in central Reading;

> Justification for current provision of PV panels;

> Justification for why MVHR is not provided to Block A;

> Demonstrate how the energy strategy performs against other metrics under the proposed Part L updates.

Wider Reading Network

4.2 It is acknowledged within RBC’s Sustainable Design and Construction SPD (December 2019) that the provision of district heating is rarely something that can be achieved by a developer as part of a single development. Nonetheless, certain infrastructural provisions are sought from developments within the four central heat clusters identified within the SPD for central Reading. The provisions include wet heating distribution systems and allowances within decentralised heating plant rooms for connection apparatus (such as pipework and heat exchangers). A capped-off connection point may also be sought.

4.3 As part of the energy strategy for the nearby Kenavon Drive development discussions were sought with RBC about plans for the development, but no details were forthcoming. It is also mentioned within Element Energy's critical review of the Vastern Road strategy how the proposed 'online' date for any DH networks is currently unknown.

4.4 Later in the same report it is stated that, if a communal heating system is ultimately selected for Vastern Road, that it is RBC who should provide details of the proposed DH network(s) in the vicinity of the development, rather than the onus being placed on Berkeley Homes to extract this information from RBC.

4.5 The fundamental risk is related to a lack of clear plans and timescales for any area heat network. As stated in the Element Energy report, any network needs to be public sector led. Thus, clear direction for its development needs to come from RBC.

4.6 In the absence of clear and detailed plans, a significant risk remains that any provisions built into the Vastern Road development in anticipation of connection to a wider area network will remain just as provisions. Residents may then be trapped indefinitely on an energy strategy which was intended to act only as an interim set-up prior to a wider connection. Should heating costs be demonstrably higher with these provisions in place than without, it could be considered an unreasonable cost penalty on residents.

PV Panels & Mechanical Ventilation Systems

4.7 The submitted Energy Statement proposed the application of a total of 70kWp of PV panels, installed across four separate roof spaces. Appendix D provides the marked up roofplan issues with the Energy Statement.

4.8 The four selected roof spaces are most appropriate as they are not shaded for lengthy periods of the day by neighbouring taller blocks. Additionally, concerns over aesthetics are minimised as most residents will be unable to see the panels.

4.9 The reasoning for not applying PV panels on the remaining roof spaces is as follows:

> Access – Blocks C, D, F and G are sloped roofs where access for installation and maintenance activities presents difficulties;

> Shading – The remaining flat roof spaces on Blocks A and B are impacted by shading from much taller towers. Both towers are orientated to the south of these available roofspaces. Images are shown below in Figure 4.

Figure 4 – Lower Roofspaces for Blocks A (left) and B (right)

4.10 MVHR systems have been proposed for all blocks except for Block A. This ensures that nearly 90% of the development is provided with high efficiency heat recovery systems.

4.11 Block A is proposed to be provided with high efficiency cMEV systems. All CO_2 reductions required under both current Part L and planning policy are achieved with the specification presented in the Energy Statement. It is proposed to therefore retain the cMEV systems for Block A on the basis it represents a fairly small proportion of the site, with heating demands already considered low as as result of a high-performance fabric specification.

Consultation Part L 2020 – Other Metrics

4.12 The submitted energy strategy utilised SAP 10.1 CO_2 emission factors in order to demonstrate the longer-term environmental trajectory for direct electric heating. Element Energy are also seeking to test the proposed strategy against other metrics set out in the consultation Part L. This includes:

> Primary energy;

> Householder affordability;

> Future-proofing to be ready for low-carbon heating systems;

> Updated minimum fabric and services standards.

4.13 Element Energy note that work undertaken on costs (as shown in Section 2) will be sufficient to cover householder affordability, and that the proposed fabric strategy would likely achieve any uplift in minimum standards for fabric and services.

4.14 Hodkinson Consultancy have undertaken analysis of primary energy and CO_2 under the consultation Part L 2020 for all heating scenarios. It is recognised that the proposed direct electric strategy might struggle to meet the notional building primary energy target. All heat pump-led networks would, albeit the network supported by gas boilers may need to exceed the annual contribution of 60% which has been used in this report to be sure of compliance.

4.15 It is considered that the use of SAP 10.1 emission factors to show significant reductions in CO_2 emissions from direct electric heating is appropriate. The BRE SAP 10.1 manual states that 'the emission factors and primary energy factors for electricity are a 5-year projection for 2020-2025', so the trajectory towards them is ongoing and with a clear evidence base and policy platform. The use of progressively cleaner grid electricity for heating will lead to an improving environmental performance of the site. Affordability of heat also has a clear basis outside of Part L or SAP methodology for why it should play a central in role in determining the suitability of a given heating system.

4.16 The application of other metrics, such as future-proofing and primary energy, is less clear cut in terms of its standing when considered outside of the Part L and SAP framework. For instance, it could be argued that future-proofing dwellings with wet heating distribution systems, whether at an individual dwelling or connecting it into a site heating network, is not as appropriate as a direct electric system if the latter is a lower cost option for residents.

4.17 Additionally, primary energy metrics are subject to change and do not track the carbon content of the fuel as closely as the CO_2 emission factors do. They are not currently a metric used for compliance under the existing Building Regulations, and as such their weight at this point should be considered limited.

4.18 In summary, whilst it is acknowledged that the direct electric heating strategy might struggle to meet compliance with a new Part L, it is considered that the importance placed on actual CO_2 reductions and affordability of heat should be greater than that of primary energy or a future-proofing strategy.

5. CONCLUSION

5.1 Hodkinson Consultancy have been appointed by Berkeley Homes (Oxford & Chiltern) Ltd to prepare a formal response to Element Energy's critical review of the proposed Vastern Road energy strategy (dated June 2020). The strategy was originally proposed in the Energy Statement (December 2019) submitted as part of the planning application to Reading Borough Council (RBC).

5.2 Nine aspects have been raised by Element Energy where further evidence and analysis are being sought. The summary table below presents an overview of each response, as discussed within the report.

Item (from Element Energy Report)	Response
1 – Justify the claim that a centralised heat pump strategy would be higher cost for occupants than the direct electric strategy.	Cost analysis undertaken across all heat pump-led strategies has shown that for a site of Vastern Road's size a direct electric heating system will lead to significantly lower costs to residents.
2 – Demonstrate why a communal closed-loop GSHP is not feasible from a technical and cost perspective with an in-depth analysis of the opportunity for the technology.	Spatial constraints mean a closed-loop GSHP system cannot be applied at Vastern Road.
3 – Demonstrate why a communal open-loop GSHP strategy is not feasible from a technical and cost perspective with an in-depth analysis of the opportunity for the technology.	An open-loop GSHP system is unviable for Vastern Road. The application of this system would introduce significant additional cost and programme risks. Such risks could only be tenable if resident heating costs were clearly shown not to be higher than the proposed direct electric strategy.
4 – Given the proximity to the River Thames, repeat the analysis for a WSHP-led communal heating system.	An WSHP system is unviable for Vastern Road. The application of this system would introduce significant additional cost and programme risks. Such risks could only be tenable if resident heating costs were clearly shown not to be higher than the proposed direct electric strategy.
5 – Liaise with RBC regarding details of the proposed Reading DH network's vicinity to the development, such that allowance for a capped-off connection pipe from a communal	Previous engagement has been initiated in relation to the neighbouring Kenavon Drive development, however no clear plans for any area networks have been presented. In the absence of these, the risk that any

Item (from Element Energy Report)	Response
heating system can be made within the development in preparation for connection to the DH network.	interim heating strategy with future-proofing measures becomes a permanent set-up is high, thereby locking in high heating costs to residents for the site.
6 – Provide more detail on the justifications for the selection of specific roof areas available for PV installs, beyond that which is given in the Energy Statement.	The remaining roof areas which do not have PV applied are shown to be unsuitable, due either to long periods of shading (to flat roof areas) or access concerns (to sloped roof areas). All regulatory and policy targets have been achieved.
7 – Demonstrate how the energy strategy compares with other KPIs (other than SAP 10.1 carbon factors) as part of the proposed Part L updates.	The proposed strategy performs well under CO_2 and affordability. It is acknowledged that under other metrics such as primary energy and future-proofing a direct electric heating system would likely not meet these consultation Part L KPIs. However it is argued that greater importance should be placed on the former two elements due to their clearer standing outside of SAP and Part L.
8 – Provide justification for use of centralised mechanical extract ventilation (cMEV) in place of mechanical ventilation with heat recovery (MVHR) in Block A.	Nearly 90% of the development will be fitted with MVHR systems. All regulatory and policy targets have been achieved.
9 – Revisit carbon offset calculation should the energy strategy change in line with any of points 1-8.	It is not proposed to vary the submitted energy strategy, and so no adjustment of the calculation is required.

In summary, following cost and feasibility analysis it has been shown in this report that the proposed direct electric heating strategy remains the most appropriate for Vastern Road.

APPENDICES

Appendix A
Heating Costs - Breakdown

Appendix B
Heating Costs – Stress Testing

Appendix C
Open-Loop GSHP – Borehole Site Plan Availability

Appendix D
PV Panels - Roofplan

Appendix A

Heating Costs – Breakdown

Calculation of Heat Consumption Costs

Heating System	Annual Space Heating & DHW Demands (at dwelling kWh/yr)	Distribution Loss Factor	Price of Fuel (gas or electricity at p/kWh)	Efficiency of Plant	Calculated variable heat tariff (p/kWh)	Cost of Heat Use (£/dwelling/yr)
Direct Electric	3,198	1	16.6p	100%	16.6p	**£531**
ASHP (60%) & Gas Boilers (40%)	3,198	1.5	13.5p (electricity) 3p (gas)	270% (SCOP) 85% (gas boiler)	6.6p	**£212**
ASHP	3,198	1.5	13.5p	270% (SCOP)	7.5p	**£240**
WSHP	3,198	1.5	13.5p	300% (SCOP)	6.8p	**£216**
GSHP	3,198	1.5	13.5p	330% (SCOP)	6.1p	**£196**

Summary of Fixed Costs

Heating System	Maintenance (dwelling/yr)	Billing & Customer Services (dwelling/yr)	Utilities (dwelling/yr)	Capital Replacement (dwelling/yr)	Total Fixed Costs (dwelling/yr)
Direct Electric	£50			£50	**£100**
ASHP (60%) & Gas Boilers (40%)	£215	£85	£95	£290	**£685**
ASHP	£215	£85	£60	£340	**£700**
WSHP	£329	£85	£60	£371	**£845**
GSHP	£355	£85	£60	£412	**£892**

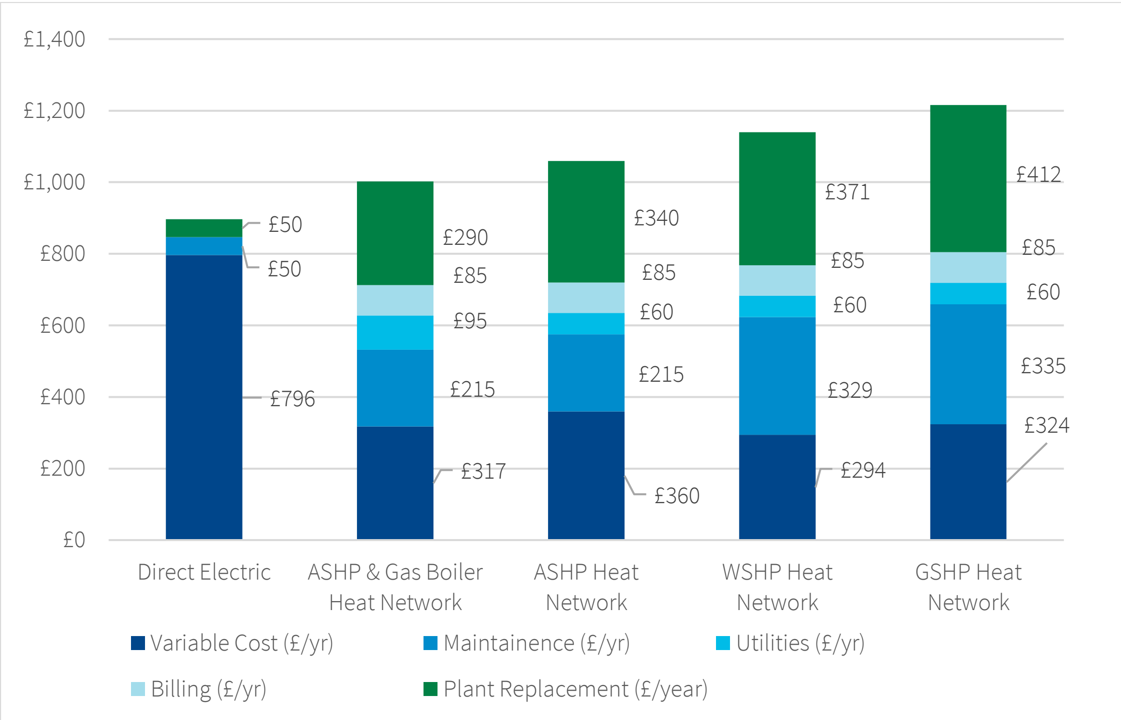
Appendix B

Heating Costs – Stress Testing

Dwelling Heat Consumption – Increase in 50%

Heating System	Annual Space Heating & DHW Demands (at dwelling kWh/yr)	Distribution Loss Factor	Price of Fuel (gas or electricity at p/kWh)	Efficiency of Plant	Calculated variable heat tariff (p/kWh)	Cost of Heat Use (£/dwelling/yr)
Direct Electric	4,797	1	16.6p	100%	16.6p	**£796**
ASHP (60%) & Gas Boilers (40%)	4,797	1.5	13.5p (electricity) 3p (gas)	270% (SCOP) 85% (gas boiler)	6.6p	**£317**
ASHP	4,797	1.5	13.5p	270% (SCOP)	7.5p	**£360**
WSHP	4,797	1.5	13.5p	300% (SCOP)	6.8p	**£294**
GSHP	4,797	1.5	13.5p	330% (SCOP)	6.1p	**£324**

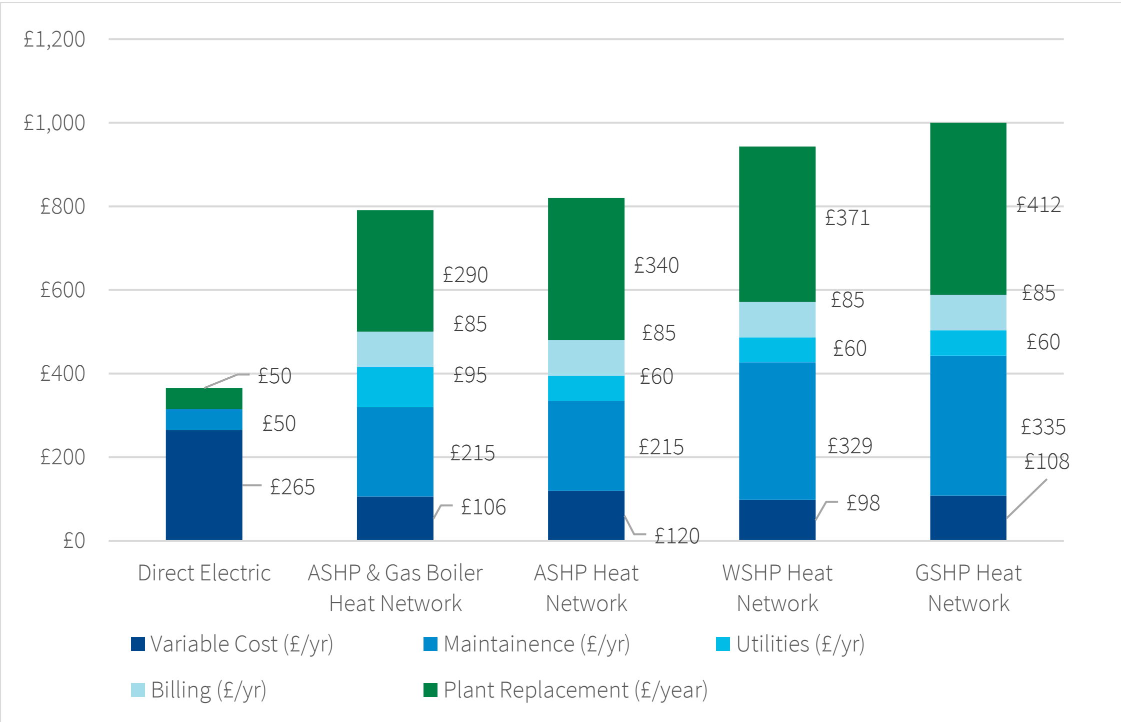
Total Costs with increased consumption



<u>Dwelling Heat Consumption – Decrease by 50%</u>

Heating System	Annual Space Heating & DHW Demands (at dwelling kWh/yr)	Distribution Loss Factor	Price of Fuel (gas or electricity at p/kWh)	Efficiency of Plant	Calculated variable heat tariff (p/kWh)	Cost of Heat Use (£/dwelling/yr)
Direct Electric	1,599	1	16.6p	100%	16.6p	**£265**
ASHP (60%) & Gas Boilers (40%)	1,599	1.5	13.5p (electricity) 3p (gas)	270% (SCOP) 85% (gas boiler)	6.6p	**£106**
ASHP	1,599	1.5	13.5p	270% (SCOP)	7.5p	**£120**
WSHP	1,599	1.5	13.5p	300% (SCOP)	6.8p	**£98**
GSHP	1,599	1.5	13.5p	330% (SCOP)	6.1p	**£108**

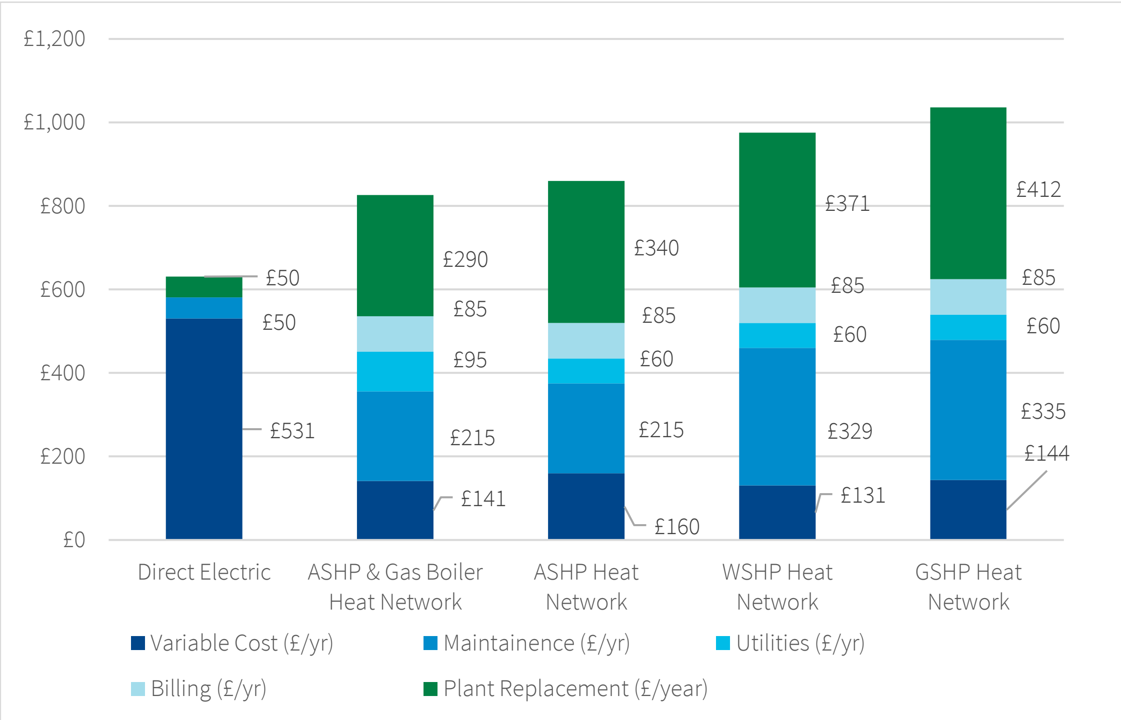
<u>Total Costs with decreased consumption</u>



Heat Networks – Distribution Loss Factor reduced to 1.2

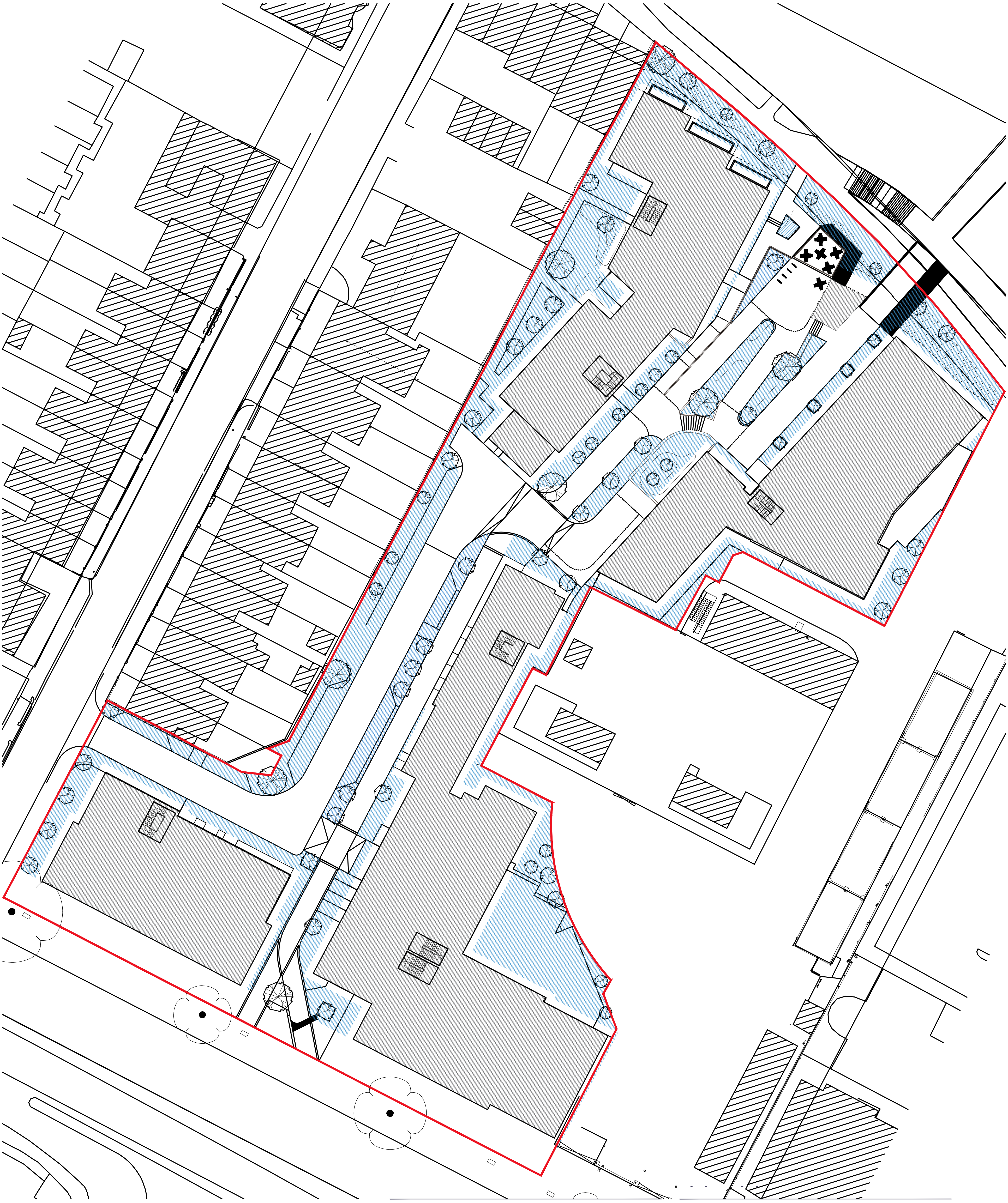
Heating System	Annual Space Heating & DHW Demands (at dwelling kWh/yr)	Distribution Loss Factor	Price of Fuel (gas or electricity at p/kWh)	Efficiency of Plant	Calculated variable heat tariff (p/kWh)	Cost of Heat Use (£/dwelling/yr)
Direct Electric	3,198	1	16.6p	100%	16.6p	**£531**
ASHP (60%) & Gas Boilers (40%)	3,198	1.2	13.5p (electricity) 3p (gas)	270% (SCOP) 85% (gas boiler)	4.4p	**£141**
ASHP	3,198	1.2	13.5p	270% (SCOP)	5.0p	**£160**
WSHP	3,198	1.2	13.5p	300% (SCOP)	4.5p	**£131**
GSHP	3,198	1.2	13.5p	330% (SCOP)	4.1p	**£144**

Total Costs with reduced heat network losses



Appendix C

Open-Loop GSHP – Borehole Site Plan Availability



Available Area for closed-loop GSHP (1939m²)

project
Vastern Road
Reading

drawing
Closed-Loop GSHP Available Area Study

date	scale @ a3	drawn
July 2020	1:500	GS

drawing number	revision
O.448.SK.001	/

revision	date	prepared	description

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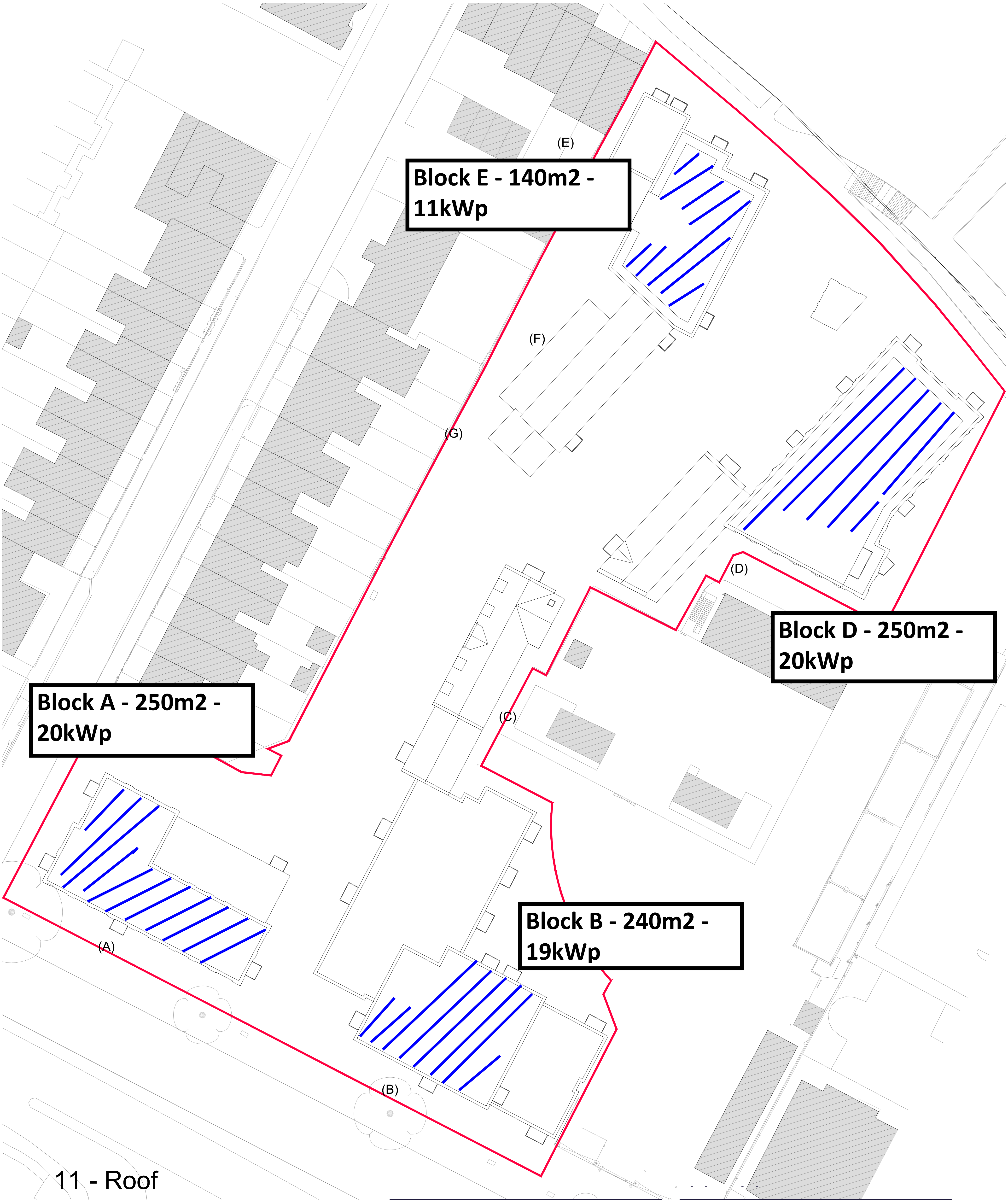
Appendix D

PV Panels - Roofplan



project
Vastern Road
Reading

drawing
Proposed Floor Plans
11 - Roof

date	scale @ a3	drawn
January 2020	1:500	EE

drawing number
448.SK.111

revision
/

revision date prepared description

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