

## SUMMARY OF ENERGY STRATEGY

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This technical note has been compiled to summarise the proposed energy strategy when assessed against The Reading Local Plan and Sustainable Design & Construction SPD. It demonstrates that consideration has been given to securing energy for the development from a decentralised energy source, and that such a scheme is not suitable or viable. It also notes that there is no existing energy provision present within the vicinity of the application site to link into. The scheme is therefore in compliance with Local Plan Policy CC4. This report also considers the proposals against the Sustainable Design and Construction SPD as set out below.

Key aspects in relation to the following, which have been described in detail in previous reports, are also summarised within this note:

- > The breakdown of costs used to establish the position that the proposed heating strategy will result in lower costs to Vastern Road residents;
- > The technical constraints in relation to the application of ground and water source heat pump decentralised systems at Vastern Road.

Further detail on the wider energy strategy can found in the following reports (all authored by Hodkinson Consultancy):

- > Energy Statement (submitted as part of the planning application) – Final V3 (December 2019);
- > Energy Strategy, Response to Element Energy – Final V3 (July 2020);
- > Energy Strategy, Further Cost Breakdown – Final V2 (September 2020).

The Energy Statement can be accessed via the planning portal. The two follow up documents, both in response to requests for further information from Element Energy, have been appended to this technical note. Where points are made within this note that have previously been presented in detail, the reference will be provided.

### Policy Context

The Policy context is provided by the Local Plan (Nov 2019) at Policies CC4 and H5c, and the Sustainable Design and Construction SPD (Dec 2019).

Table 1, overleaf, provides a summary of how the proposed energy strategy is tested against the relevant policy requirements.

| Document              | Relevant Statements from the Local Plan & SPD                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | How The Proposed Energy Strategy Addresses This                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Local Plan Policy CC4 | <p><b>Policy CC4:</b> 'In meeting the sustainability requirements of this plan, development of the sizes set out below shall demonstrate how consideration has been given to securing energy for the development from a decentralised energy source.</p> <p>Any development of more than 20 dwellings and/or non-residential development over 1,000 sq m shall consider the inclusion of decentralised energy provision, within the site, unless it can be demonstrated that the scheme is not suitable, feasible or viable for this form of energy provision.</p> <p>Where there is existing decentralised energy provision present within the vicinity of an application site, further development of 10 dwellings or more or non-residential development of 1,000 sq m or more will be expected to link into the existing decentralised energy network or demonstrate why this is not feasible.'</p> | <p>Consideration has been given to the application of decentralised energy for the supply of heating at Vastern Road. In summary the proposals have been considered against the key test of Policy CC4, which relates to the second paragraph of the policy and states that if decentralised energy provision is shown to be not suitable, feasible <b>or</b> viable, then an alternative strategy can be proposed. The reasoning is summarised as follows:</p> <ul style="list-style-type: none"> <li>&gt; The operating costs (which are passed onto residents) of the kind of decentralised systems put forward in the SPD are deemed excessive for a development of Vastern Road's size and therefore make these systems unsuitable and unviable for residents in comparison to the proposed energy strategy. Heating costs to residents would be considerably higher than the proposed energy strategy. Detailed cost breakdowns to demonstrate this have been provided in previous reports to both RBC and Element Energy, and are reiterated later in this note;</li> <li>&gt; The delivery of a decentralised energy network on site is also unviable for the Vastern Road development as these costs are considerably higher than the proposed energy strategy submitted as part of this planning application;</li> <li>&gt; There are no existing DH networks in the vicinity of the site, nor have any plans for a future one been shared. Therefore, in terms of future linkages, concerns over high residents heating bills have not been assuaged by a commitment from RBC that such an outcome may only be temporary. No details have been provided on when a connection to a wider DH network may be available, or that such a connection would result in reasonably priced heat being delivered to Vastern Road residents. It can only therefore be assumed that there is a very high potential for residents to be locked into high heating costs for many years to come.</li> </ul> |

| Document                 | Relevant Statements from the Local Plan & SPD                                                                                                                                                                                                                                                                                                                                          | How The Proposed Energy Strategy Addresses This                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|--------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                          |                                                                                                                                                                                                                                                                                                                                                                                        | <p><u>Conclusion</u></p> <p>It has therefore been concluded when assessing the proposed energy strategy against Policy CC4, that the proposed energy strategy has complied with Policy CC4, having demonstrated that the scheme is unsuitable, unfeasible or unviable for the application of decentralised energy provision.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Local Plan<br>Policy H5c | <p><b>Policy H5c:</b> 'All major new-build residential development should be designed to achieve zero carbon homes.'</p> <p>It is clarified under point 4.4.46 that a minimum on-site improvement of 35% in the sites dwelling emission rate over Part L (2013), with the remainder up to a standard of zero carbon delivered via a carbon offsetting contribution, is acceptable.</p> | <p>The proposed energy strategy for Vastern Road achieves an on-site reduction of 54.2% beyond the Part L (2013) baseline. A payment of £170,100 has been calculated to enable all remaining Regulated CO<sub>2</sub> to be offset in order to achieve a standard of zero carbon homes for the development.</p> <p>SAP 10.1 emission factors have been used in the assessment, with robust justification provided to both RBC and Element Energy. This is reiterated elsewhere in this note, with steers to where this has been outlined in more detail.</p> <p>The requirements of Policy H5c have been met.</p>                                                                                                                                                                                                                                                                                                                                                                                         |
| SPD                      | Reiteration of the key expectations of Policy CC4 and decentralised energy, including the statement 'unless it can be demonstrated that the scheme is not suitable, feasible or viable for this form of energy provision'.                                                                                                                                                             | As per response to Policy CC4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| SPD                      | Preference for GSHP over ASHP systems. If GSHP systems are discounted then technical analysis at the detailed planning application stage should be provided outlining the constraints.                                                                                                                                                                                                 | <p>A closed-loop GSHP system is unfeasible and unsuitable for the site due to there being insufficient space for boreholes. This is summarised further in this note.</p> <p>An open-loop GSHP may encounter constraints associated with ground contamination risk which have been outlined in the application. This is unable to be affirmed until detailed site studies have been undertaken, which would result in further delays to the build programme and increases in costs. Environment Agency abstraction permits would likely also be required.</p> <p>An ASHP system would not encounter any of the above technical constraints, however as stated in the response to Policy CC4 it is expected to result in excessive heating costs for residents (as would the GSHP system) as well as high upfront costs making this an unsuitable and unviable option when compared to the proposed energy strategy. This is outlined in detail in both of the follow-up reports appended to this note.</p> |

| Document | Relevant Statements from the Local Plan & SPD                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | How The Proposed Energy Strategy Addresses This                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SPD      | Combustion-based CHP should be avoided                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | The proposed energy strategy provides no combustion-based plant                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| SPD      | <p>Where developments are located in high priority areas for district heating (as identified by the SPD) and where there is no existing network to connect to, the following provisions should be made:</p> <ul style="list-style-type: none"> <li>- Designing the development with wet space heating and hot water distribution systems, so that the building heat distribution network can interact with a DH network;</li> <li>- Space provision in heating plant rooms for connection to a DH network;</li> <li>- Where necessary, provide buried and capped-off DH pipework from the development's plant room to a convenient location in preparation for connection to a DH network.</li> </ul> | <p>It is acknowledged that the Vastern Road site lies within one of the priority areas identified within the SPD. No existing networks are available to connect to, and crucially no information has been provided by RBC for potential future connections.</p> <p>It is recognised that the proposed heating strategy does not deliver wet heating distribution, either within the homes or at building level. Further explanation on this can be found elsewhere in this note.</p> <p>Due to the absence of information related to any future wider DH network, it is considered unsuitable to provide a buried and capped-off connection. This could remain unused indefinitely, with the development incurring maintenance costs associated with ensuring the pipework does not degrade. Similarly, reserving space for a heating plant room for connection to a network which may never be implemented is not considered appropriate. For both of the above reasons, a DH connection would also impact on the overall viability of the site.</p> |

Further details are provided below in support of the summary statements set out in Table 1.

## The Proposed Energy Strategy

The proposed energy strategy, as described in the Energy Statement, prioritises as a first principle a reduction in energy demands. This is delivered through a number of energy efficiency measures, such as:

- > High efficiency MVHR (Mechanical Ventilation with Heat Recovery) systems in 87% of all homes. These systems are assisted by the high airtightness standards targeted;
- > Bespoke modelling of construction details to minimise the impact of thermal bridges;
- > Element U-values (floors, roofs, walls, glazing) which go far beyond the minimum standards under current Part L (2013), and also meet the standards earmarked in consultation Part L (2020).

A substantial array of photovoltaic (PV) panels (total 70kWp) is also to be provided, enabling the site to generate its own low carbon power.

Heating and hot water demands are proposed to be met via direct electric panels coupled with a highly efficient hot water cylinder.

## Use of SAP 10.1 Emission Factors

It is confirmed that the energy strategy is compliant with Part L (2013) using SAP 2012 emission factors.

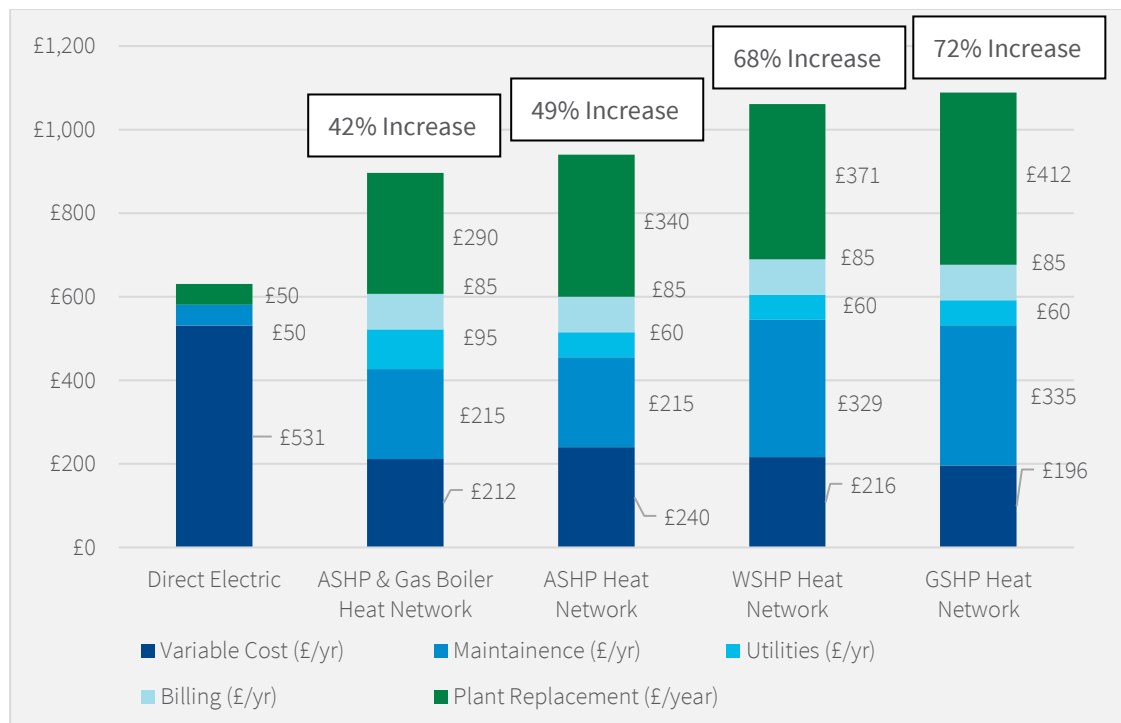
Nonetheless, the energy strategy has been submitted utilising SAP 10.1 emission factors, in order to better reflect the actual carbon performance of a strategy linked to the electricity grid. SAP 2012 emission factors, although still used for Part L (2013) compliance, are outdated and do not represent the current (or future trajectory) carbon intensity of the grid. The following justification for the use of SAP 10.1 emission factors was provided in the Response to Element Energy (July 2020) report (point 4.15).

‘It is considered that the use of SAP 10.1 emission factors to show significant reductions in CO<sub>2</sub> 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.’

Further context was provided in the Energy Statement (section 3) which showed how the use of existing SAP 2012 emission factors could lead to an inappropriate energy strategy.

## Cost Analysis

A detailed extrapolation of the potential cost to residents of a low carbon communal system when compared against the proposed heating strategy was provided in both follow-up reports to Element Energy. Cost calculations are shown in Figure 1, below.



Version: 4

Date: 19 October 2020

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### **Breakdown of Cost Information Provided**

Table 2, below, shows what cost information has been provided to RBC and Element Energy, contained within both follow-up reports.

| <b>Cost Element</b>                                | <b>Information Provided</b>                                                                                                                                                                                                                                                                                                                                                                                                                        |
|----------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Variable Costs (i.e. for the heat consumed)</b> | <p>A clear methodology, with all factors which may affect the variable costs (such as fuel price, network efficiency, and energy demands) has been provided in the Response to Element Energy report (see Appendix A). Explanation is also provided in points 2.11 – 2.12 of that report.</p> <p>Stress testing, where enhanced assumptions (i.e. improved efficiencies) have been used has also been shown, in Appendix B of the same report.</p> |
| <b>Maintenance Costs</b>                           | <p>This has been explained in both follow-up reports (see points 2.19 – 2.22 in the Response to Element Energy report, and pg 5 of the Further Cost Breakdown report). The elements contained within have been broken down and explained. It is deemed commercially sensitive to name the specific schemes where appropriate cost information has been used. Where manufacturers data or tenders have been used this is also stated.</p>           |
| <b>Replacement Costs</b>                           | <p>Full breakdown in a table format provided, shown in Table 2 of the Further Cost Breakdown report.</p>                                                                                                                                                                                                                                                                                                                                           |
| <b>Utility Costs</b>                               | <p>Explanation of what this cost covers provided in the Response to Element Energy report. See points 2.17 – 2.18. All specific utility elements contained within the costs shown in Figure 1 are explained.</p>                                                                                                                                                                                                                                   |
| <b>Billing Costs</b>                               | <p>Explanation of what this cost covers provided in the Response to Element Energy report. See points 2.14 – 2.16. It is stated that the £85/yr (for all communal systems) is the average of a number of tender returns received by Hodkinson Consultancy from specialist heat network metering/billing companies.</p>                                                                                                                             |

### **Further Correspondence with Element Energy**

Two reports have been received from Element Energy in relation to the proposed energy strategy. The second of these responded to both of Hodkinson Consultancy's follow-up reports, with specific focus on costs. Key observations from this are summarised as follows:

- > Best-case assumptions in relation to variable, maintenance, and replacement costs have been made, which reduce the costs stated by Hodkinson Consultancy in all these stated areas. Some of

these assumptions, such as the significant reduction to replacement costs, have not been provided with an evidence basis;

- > Notwithstanding the validity of these best-case assumptions, the heat costs from the proposed strategy still represent the most cost-effective strategy to residents.

It is stressed that the likelihood of any of the communal systems being able to claim Renewable Heat Incentive (RHI) is considered very low, due to the cut-off dates for registration and the commissioning readiness test points. The current proposals for the incoming Clean Heat Grant would not have any impact on reducing the operational costs of any of these systems.

## **Technical Limitations of GSHP & WSHP Networks**

High level reasoning was provided in Hodkinson Consultancy's 'Response to Element Energy' report (V3, July 2020) as to why GSHP and WSHP decentralised networks were not considered suitable for the site. It is worth noting that no mention of water source heat pumps (WSHPs) is made in either the Local Plan or the SPD.

The reasoning for their exclusions can be summarised as follows:

- > There is insufficient suitable space for the installation of the estimated required number of boreholes for a closed-loop GSHP system. This was shown in a site plan provided in Appendix C of the Response to Element Energy report, with explanation provided in points 3.8 – 3.12;
- > An open-loop GSHP system would not be limited by the same spatial constraints. However, there is a potential contamination risk associated with a site which used to be a power station. In addition to this, no current data exists about the available heat which could be obtained from nearby aquifers. Significant cost and time would need to be given to investigate the potential for this system, therefore potentially delaying the build programme, which could only be justified if there remained a strong likelihood that any installed system of this type could result in secure and reasonably priced heat to residents. Significant delays could also accrue as a result of securing an abstraction license from the Environment Agency;
- > As with open-loop GSHP, it may be possible to design and install a WSHP system. Where the former may encounter limitations with ground contamination and heat availability, the latter requires the negotiation of rights to use third-party land between the site and the River Thames which could prove complicated. It will also require consultation with the Environment Agency, and confidence that ongoing permission for abstraction can be secured for the duration of the development lifespan. Significant risks therefore remain that access to this energy source may be cut-off, either prior to occupations or later in the development life. However, the core concern remains one of operating costs, and that justification for committing resources to the development of a strategy which is expected to result in much higher resident heating costs, cannot be made.

It is worth summarising in line with the above that it has not been stated that any of these systems (with the exception of closed-loop GSHP) are impossible on the Vastern Road site. Rather, the position in order to

achieve any of these energy strategy options is that they are unviable and unsuitable. In addition, the running costs associated with systems of this type on development of this scale are excessive and therefore a reasonable justification for pursuing detailed design work cannot be made. Additional site-specific technical challenges are only likely to exacerbate this.

Scale matters because the majority of the costs for these systems are fixed, i.e. related to maintenance, billing, and replacement activities. At larger scales more connections to these networks mean there are a larger number of customers to share these costs, thus overall heating charges are lower. At a smaller scale, however, costs increase substantially and result in higher charges to residents than individual heating systems. This is exacerbated by the lack of industry skills and expertise in regard to GSHP and WSHP systems in particular.

The proposed direct electric heating strategy will not result in programme delays, nor unreasonable costs for heating to residents. The demonstration that decentralised energy provision is not suitable and not viable for Vastern Road shows that the direct electric strategy proposed is the most appropriate.

## **Conclusion**

We note that the Council acknowledges the positive approach to reducing energy demands through the building fabric. This summary note, in addition to the three former reports previously issued, demonstrates that when considered against the Planning Policy framework of Policy HS5, the Sustainable Construction and Design SPD and more importantly Policy CC4, a decentralised energy solution cannot be supported as it has been demonstrated to be unfeasible, unsuitable or unviable.

# **Appendix 1**

**Energy Strategy: Response to  
Element Energy (July 2020, V3)**



**HODKINSON**



**Energy Strategy:  
Response to Element  
Energy**

Berkeley Homes (Oxford & Chiltern)  
Ltd.

# **Vastern Road**

Final V3

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Date: July, 2020

## DOCUMENT CONTROL RECORD

### REPORT STATUS: FINAL

| Version | Date     | Reason for issue | Author | Checked by | Approved for Issue by Project Manager |
|---------|----------|------------------|--------|------------|---------------------------------------|
| v.1     | 10.07.20 | Draft            | JP     | MB         | JP                                    |
| v.2     | 15.07.20 | Final            | JP     | MB         | JP                                    |
| v.2     | 17.07.20 | Final            | JP     | MB         | JP                                    |

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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.

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# 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.

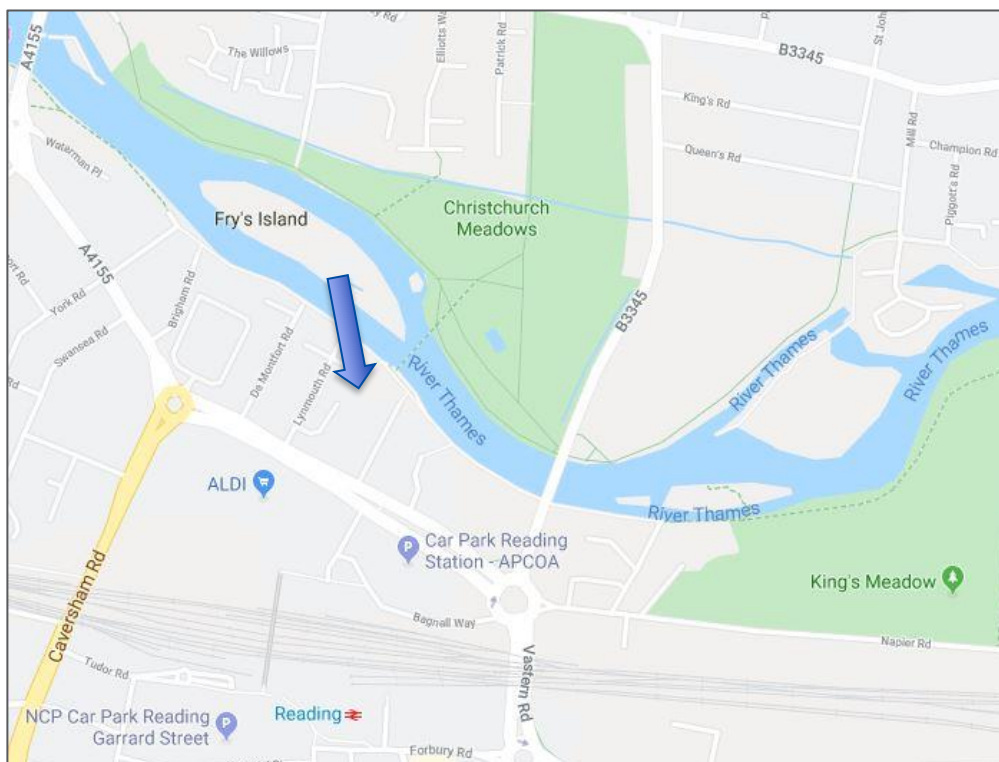


Figure 1: Site Location (Source: Imagery @ 2020 Google, Map data ©2020 Google)

## 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<sub>2</sub> 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.

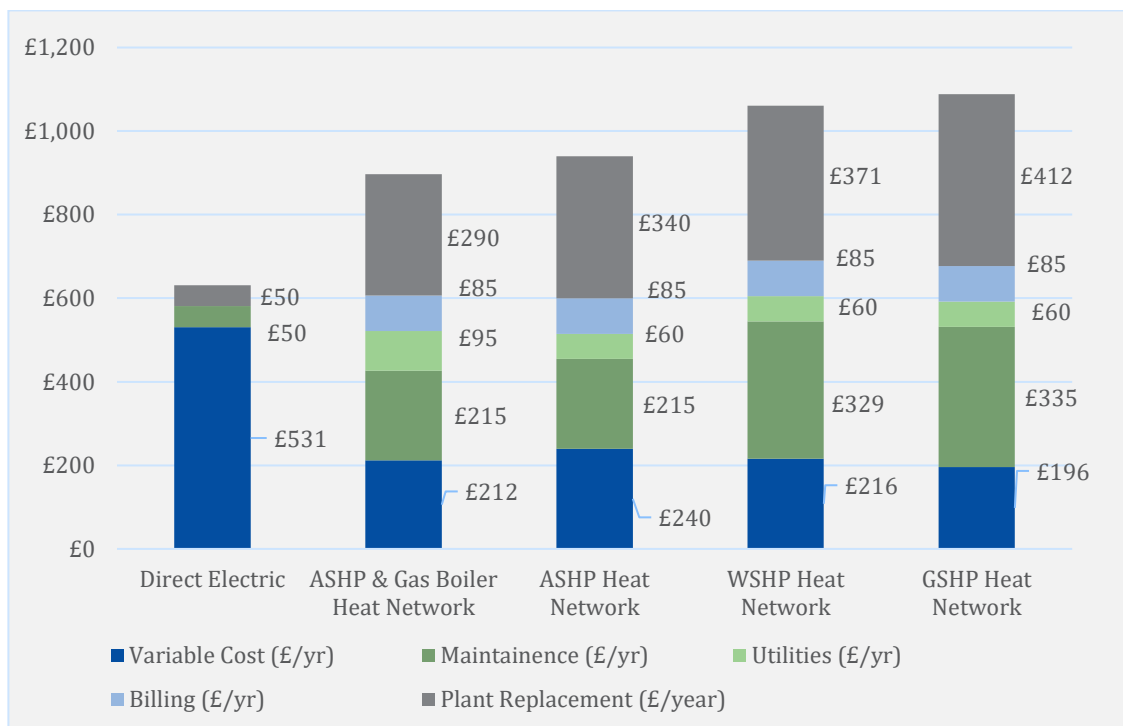
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## 2. COST ANALYSIS – PROPOSED HEATING STRATEGY VS HEAT PUMP SOLUTIONS

- 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.

## 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:

$$((\text{Heating Demands at Energy Centre} \div \text{Plant Efficiency}) \times \text{Price of Fuel}) \div \text{Heating Demands at Dwelling}.$$

### 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 – 4,000m<sup>2</sup> 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 3-4,500m<sup>2</sup> 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 1,939m<sup>2</sup>. 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

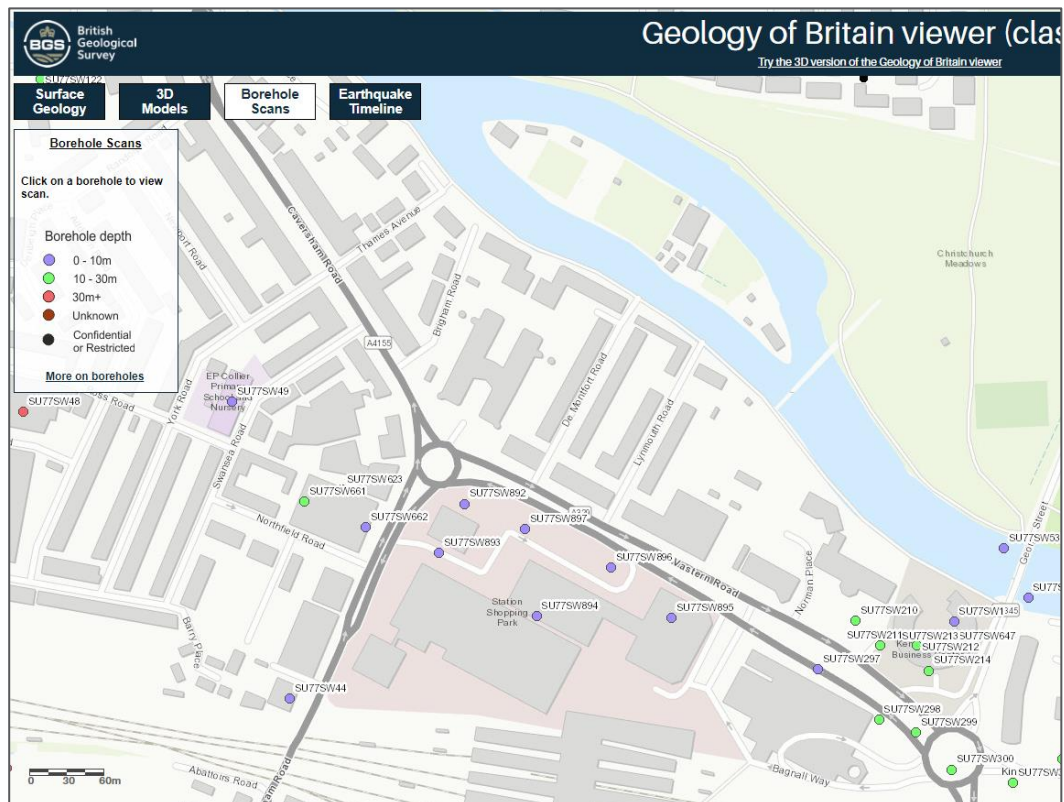
## System Description

- 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 2 No. 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 GSHP 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 STRATEGY**

- 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<sub>2</sub> 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 a result of a high-performance fabric specification.

## Consultation Part L 2020 – Other Metrics

- 4.12** The submitted energy strategy utilised SAP 10.1 CO<sub>2</sub> 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<sub>2</sub> 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<sub>2</sub> 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 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<sub>2</sub> 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<sub>2</sub> 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                                                                                                                                                                                                                                                                                          |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>1</b> – 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.                                                                                               |
| <b>2</b> – 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.                                                                                                                                                                                                             |
| <b>3</b> – 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. |
| <b>4</b> – 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.           |
| <b>5</b> – 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.                                                                                                                                                                                                                                                  |
| <b>6</b> – 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.                                                                                                                                                                |
| <b>7</b> – 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 <sub>2</sub> 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. |
| <b>8</b> – 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.                                                                                                                                                                                                                                                                                        |
| <b>9</b> – 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)<br>3p (gas)             | 270% (SCOP)<br>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                            |

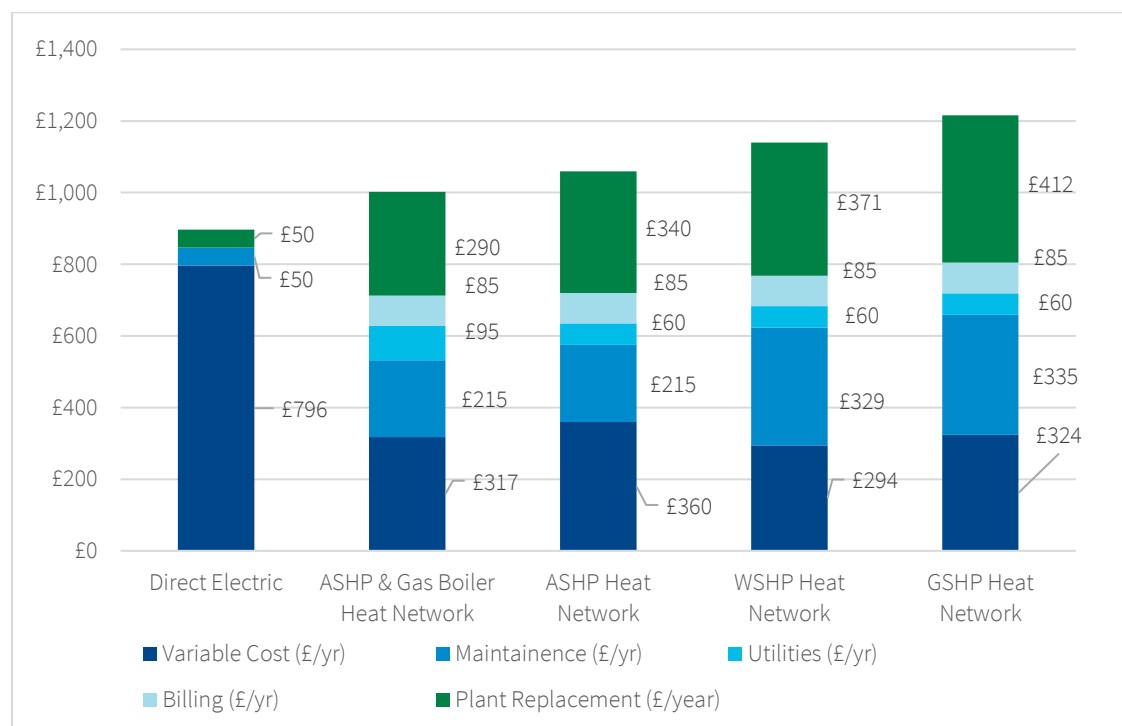
# **Appendix B**

## **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                                   | <b>£796</b>                      |
| ASHP (60%) & Gas Boilers (40%) | 4,797                                                   | 1.5                      | 13.5p (electricity)<br>3p (gas)             | 270% (SCOP)<br>85% (gas boiler) | 6.6p                                    | <b>£317</b>                      |
| ASHP                           | 4,797                                                   | 1.5                      | 13.5p                                       | 270% (SCOP)                     | 7.5p                                    | <b>£360</b>                      |
| WSHP                           | 4,797                                                   | 1.5                      | 13.5p                                       | 300% (SCOP)                     | 6.8p                                    | <b>£294</b>                      |
| GSHP                           | 4,797                                                   | 1.5                      | 13.5p                                       | 330% (SCOP)                     | 6.1p                                    | <b>£324</b>                      |

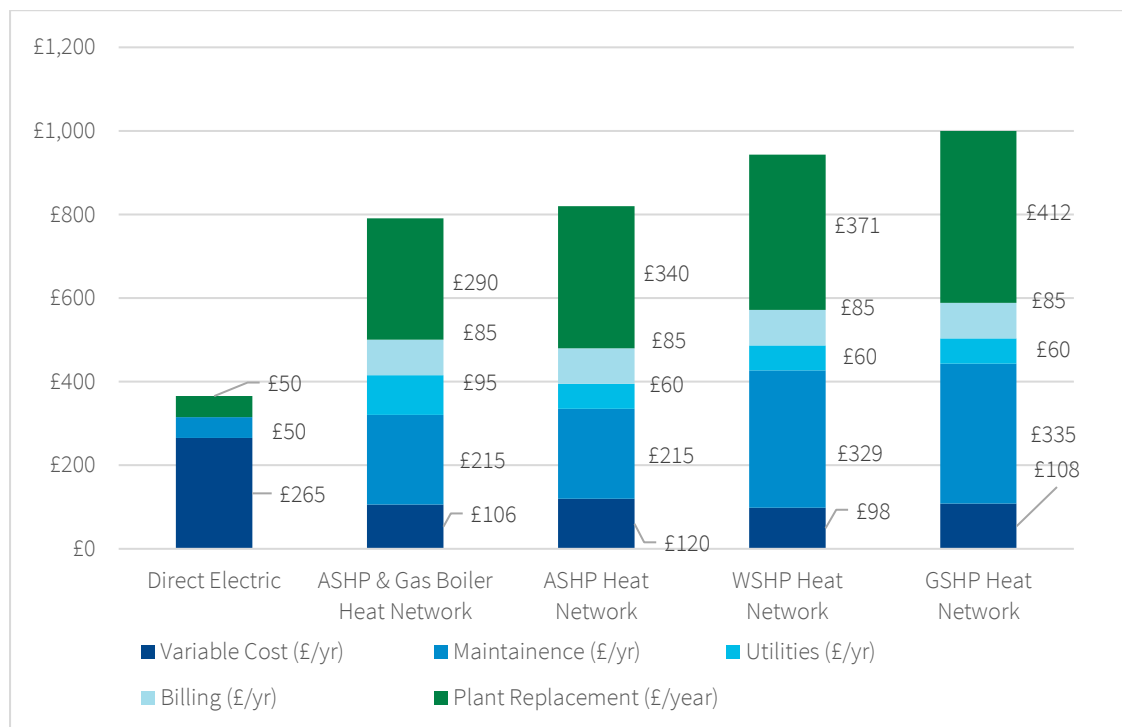
## Total Costs with increased consumption



## Dwelling Heat Consumption – Decrease by 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                | 1,599                                                   | 1                        | 16.6p                                       | 100%                            | 16.6p                                   | <b>£265</b>                      |
| ASHP (60%) & Gas Boilers (40%) | 1,599                                                   | 1.5                      | 13.5p (electricity)<br>3p (gas)             | 270% (SCOP)<br>85% (gas boiler) | 6.6p                                    | <b>£106</b>                      |
| ASHP                           | 1,599                                                   | 1.5                      | 13.5p                                       | 270% (SCOP)                     | 7.5p                                    | <b>£120</b>                      |
| WSHP                           | 1,599                                                   | 1.5                      | 13.5p                                       | 300% (SCOP)                     | 6.8p                                    | <b>£98</b>                       |
| GSHP                           | 1,599                                                   | 1.5                      | 13.5p                                       | 330% (SCOP)                     | 6.1p                                    | <b>£108</b>                      |

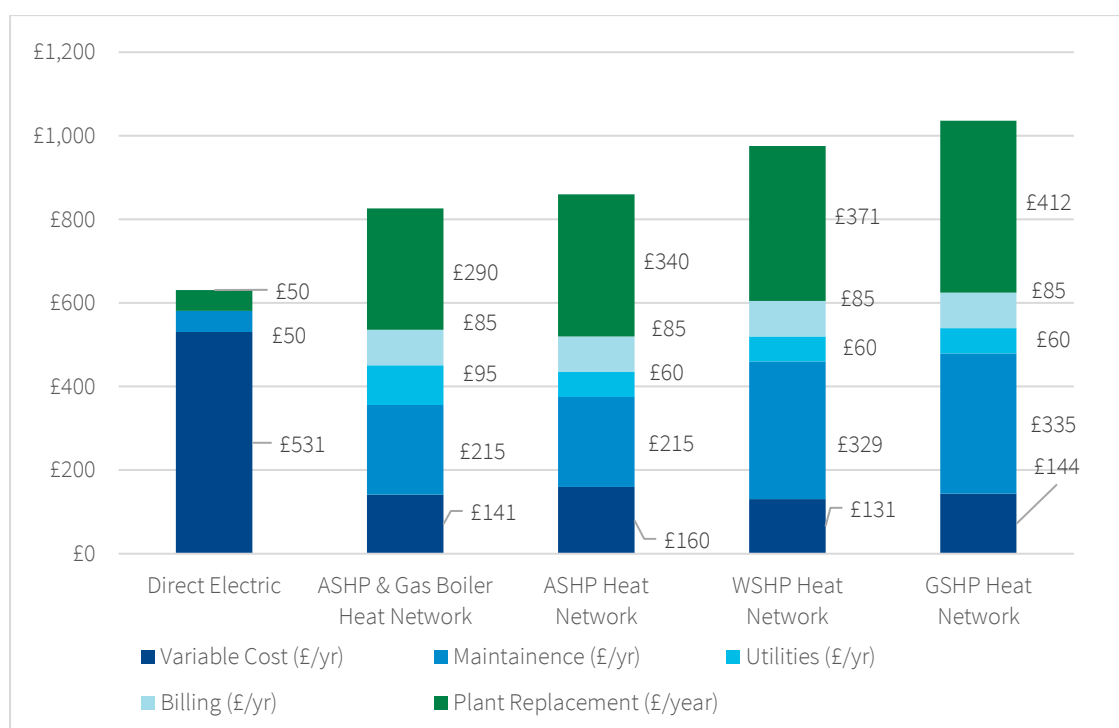
## Total Costs with decreased consumption



## 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                                   | <b>£531</b>                      |
| ASHP (60%) & Gas Boilers (40%) | 3,198                                                   | 1.2                      | 13.5p (electricity)<br>3p (gas)             | 270% (SCOP)<br>85% (gas boiler) | 4.4p                                    | <b>£141</b>                      |
| ASHP                           | 3,198                                                   | 1.2                      | 13.5p                                       | 270% (SCOP)                     | 5.0p                                    | <b>£160</b>                      |
| WSHP                           | 3,198                                                   | 1.2                      | 13.5p                                       | 300% (SCOP)                     | 4.5p                                    | <b>£131</b>                      |
| GSHP                           | 3,198                                                   | 1.2                      | 13.5p                                       | 330% (SCOP)                     | 4.1p                                    | <b>£144</b>                      |

## Total Costs with reduced heat network losses



# **Appendix C**

## **Open-Loop GSHP – Borehole Site Plan Availability**



Available Area for  
closed-loop GSHP  
(1939m<sup>2</sup>)



project  
Vastern Road  
Reading

drawing  
Closed-Loop GSHP Available Area Study

date  
July 2020

scale @ a3  
1:500

drawn  
GS

drawing number  
O.448.SK.001

revision  
/

revision  
date

prepared  
description

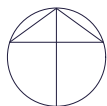
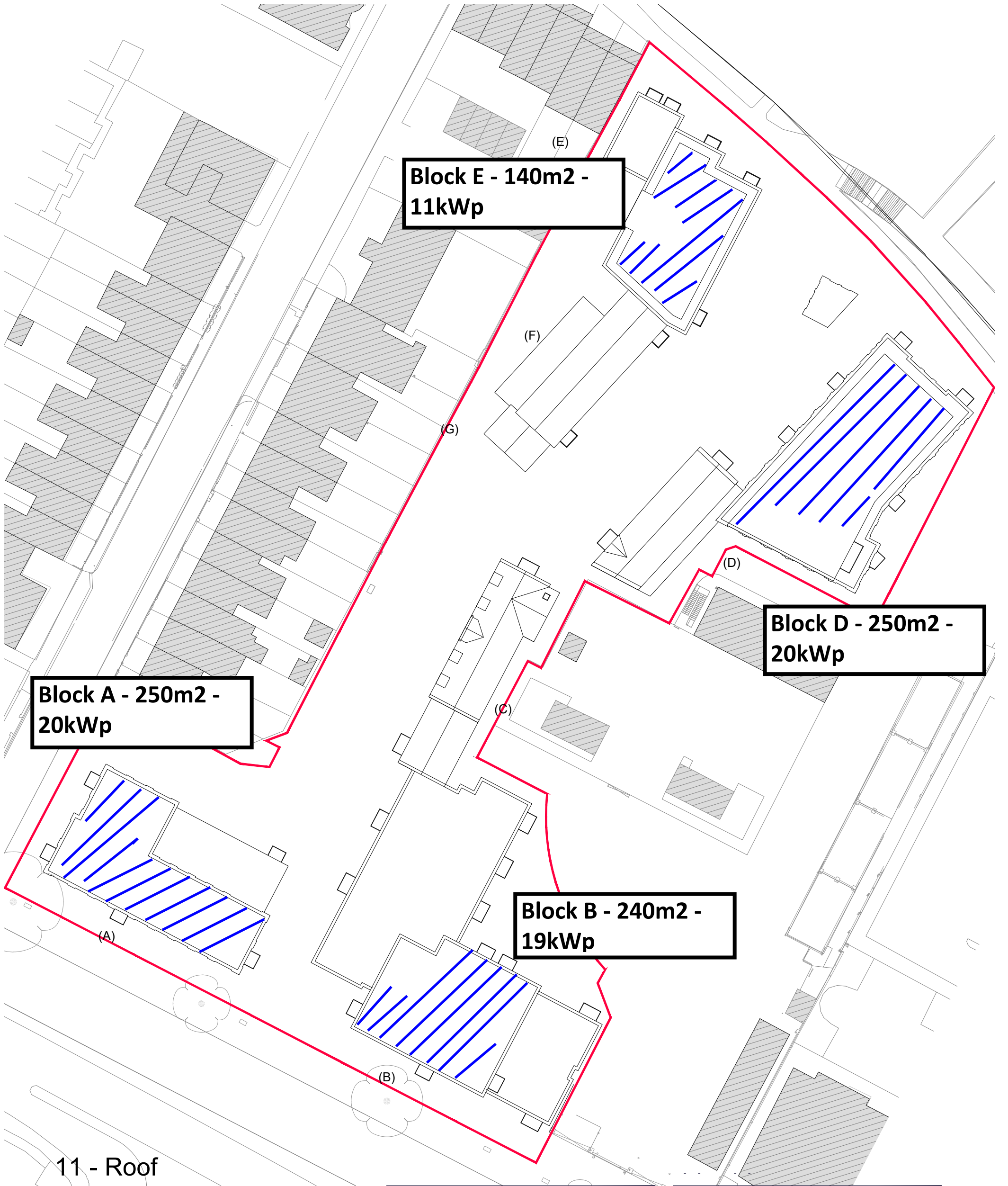
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Farnham Royal  
SL2 3RQ

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# **Appendix D**

## **PV Panels - Roofplan**



project  
Vastern Road  
Reading

drawing  
Proposed Floor Plans  
11 - Roof

date  
January 2020

scale @ a3  
1:500

drawn  
EE

drawing number  
448.SK.111

revision  
/

revision  
date  
prepared  
description

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# **Appendix 2**

**Further Cost Breakdown  
(*Breakdown of Predicted  
Heating Costs*) - (September  
2020, V2)**

## BREAKDOWN OF PREDICTED HEATING COSTS

This technical note has been compiled to provide further detail on the costs submitted in the 'Energy Strategy: Response to Element Energy' report (Hodkinson Constancy, July 2020).

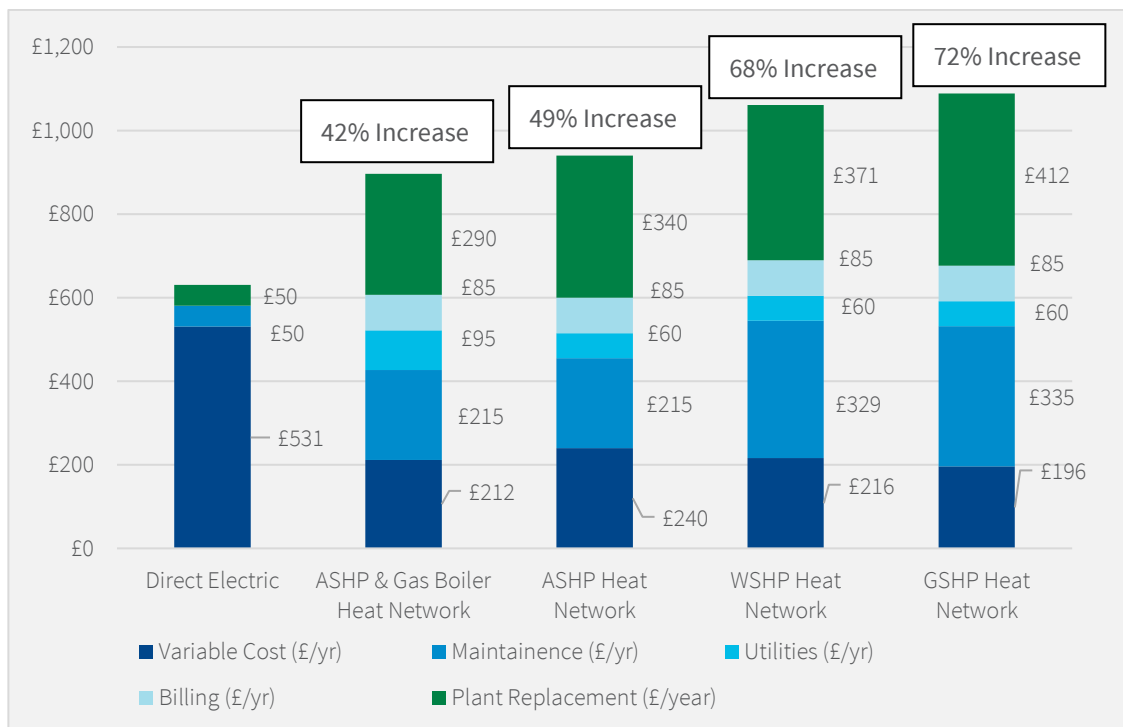
Element Energy have requested supporting calculations, with specific reference to the following:

- > Assumptions on heat pump efficiencies;
- > Capital cost assumptions for all heat pump scenarios;
- > What equipment has (and by extension has not) been included in the replacement costs.

### Position Summary

The position put forward to Reading Borough Council and their appointed energy consultants, Element Energy, is that a heat pump-led site heating network for the Vastern Road development would result in unacceptably high costs to residents. The graph, below, was provided with supplementary explanation in the report issued in July.

**Figure 1: Estimated Resident Heat Costs (£/yr)**



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 (open-loop ground source) - **£1,088/yr** (72% increase).

## Heat Pump Efficiencies

The following seasonal efficiencies (SCOPs) have been used in the determination of the variable heating tariff for the heat pump scenarios:

- > Air Source – 2.70;
- > Water Source – 3.00;
- > Ground Source – 3.30.

Stress testing on demand changes (50% more or 50% less than the SAP model outputs) was undertaken in the July report, as well as the impact of reducing network heat losses (from a Distribution Loss Factor of 1.5 to 1.2). In all instances direct electric heating remained the most cost-effective heating strategy for residents.

An example calculation has also now been completed where the SCOP for ASHPs has been raised to what is considered a maximum achievable value. This has been taken to be 3.30, in line with manufacturer datasheets. ASHPs have been used in these example calculations because in spite of the lower efficiencies achievable compared to WSHP or GSHPs, the overall cost package is lower due to the maintenance and replacement costs.

The variable costs are compared in the Table 1 below for an ASHP-only heat network. Cost reductions would be lower for the hybrid ASHP and boiler strategy as the boiler efficiency remains as before.

**Table 1: Cost Reductions with Improved Efficiencies**

| SCOP | Loss Factor | Variable Cost (£/yr) | Total Cost (£/yr) |
|------|-------------|----------------------|-------------------|
| 2.70 | 1.5         | £240                 | £940              |
| 2.70 | 1.2         | £192                 | £892              |
| 3.30 | 1.2         | £157                 | £857              |

An ASHP network with an SCOP of 3.30 and a Distribution Loss Factor of 1.2 (equivalent to 16.7% losses between Energy Centre and dwellings) would represent a very efficient network, one which goes beyond best practice design standards such as CIBSE CP1 and is considered very challenging to implement. Nonetheless, even with a cost reduction of £83/yr taken into account from this set-up the direct electric system at £631/yr still remains much more cost-effective to residents.

## Replacement Cost Assumptions

The key components within the replacement costs for all heat pump scenarios have been broken down and are shown in Table 2.

**Table 2: Replacement Cost Components**

| Item                                   | Estimated Capital Cost | Expected Lifespan | Replacement Cost per Year |
|----------------------------------------|------------------------|-------------------|---------------------------|
| <b>Common Plant (in all scenarios)</b> |                        |                   |                           |
| Circulation Pumps                      | £30,000                | 15                | £2,000                    |
| Pressurisation & Expansion Units       | £14,000                | 15                | £993                      |
| De-Gasser & Filtration Units           | £20,000                | 15                | £1,333                    |
| BMS                                    | £120,000               | 12.5              | £9,600                    |
| Dwelling HIUs (x209)                   | £313,500               | 12.5              | £25,080                   |
| Heat Meters (x220)                     | £44,000                | 10                | £4,400                    |
| Supporting Electricals                 | £30,000                | 15                | £2,000                    |
| <b>Total</b>                           | <b>£571,500</b>        |                   | <b>£45,347</b>            |
| <b>Total per Dwelling</b>              | <b>£2,748</b>          |                   | <b>£217</b>               |
| <b>ASHP / Gas Boiler Hybrid</b>        |                        |                   |                           |
| ASHPs (inc. thermal stores)            | £200,000               | 15                | £13,333                   |
| Gas Boilers                            | £40,000                | 20                | £2,000                    |
| <b>Total</b>                           | <b>£240,000</b>        |                   | <b>£15,333</b>            |
| <b>Total per Dwelling</b>              | <b>£1,154</b>          |                   | <b>£73</b>                |
| <b>ASHP Only</b>                       |                        |                   |                           |
| ASHPs (inc. thermal stores)            | £360,000               | 15                | £24,000                   |
| Supporting Electricals                 | £25,000                | 15                | £1,667                    |
| <b>Total</b>                           | <b>£385,000</b>        |                   | <b>£25,667</b>            |
| <b>Total per Dwelling</b>              | <b>£1,851</b>          |                   | <b>£123</b>               |
| <b>WSHP</b>                            |                        |                   |                           |
| WSHPs (inc. thermal stores)            | £360,000               | 12.5              | £28,800                   |
| Supporting Electricals                 | £25,000                | 15                | £1,667                    |
| Heat Exchanger                         | £15,000                | 20                | £750                      |
| Pumps                                  | £15,000                | 15                | £1,000                    |
| <b>Total</b>                           | <b>£415,000</b>        |                   | <b>£32,217</b>            |

|                              |                 |      |                |
|------------------------------|-----------------|------|----------------|
| <b>Total per Dwelling</b>    | <b>£1,995</b>   |      | <b>£154</b>    |
| <b>GSHP (Open-Loop)</b>      |                 |      |                |
| WSHPs (inc. thermal stores)  | £360,000        | 12.5 | £28,800        |
| Supporting Electricals & BMS | £40,000         | 15   | £2,667         |
| Borehole Pumps               | £60,000         | 15   | £4,000         |
| Borehole Sensors/Controls    | £50,000         | 12.5 | £4,000         |
| Heat Exchanger               | £25,000         | 20   | £1,250         |
| <b>Total</b>                 | <b>£535,000</b> |      | <b>£40,717</b> |
| <b>Total per Dwelling</b>    | <b>£2,572</b>   |      | <b>£195</b>    |

Table 3, below, summarises these costs and demonstrates that they align with the ‘Energy Strategy: Response to Element Energy’ report (Hodkinson Constancy, July 2020).

**Table 3: Summary of Replacement Costs (£/yr/dwelling)**

| <b>Heating Scenario</b>        | <b>Common Plant Replacement (£/yr)</b> | <b>Scenario Plant Replacement (£/yr)</b> | <b>Total (£/yr)</b> |
|--------------------------------|----------------------------------------|------------------------------------------|---------------------|
| <b>ASHPs &amp; Gas Boilers</b> | £217                                   | £73                                      | <b>£290</b>         |
| <b>ASHPs</b>                   | £217                                   | £123                                     | <b>£340</b>         |
| <b>WSHPs</b>                   | £217                                   | £154                                     | <b>£371</b>         |
| <b>GSHPs (open-loop)</b>       | £217                                   | £195                                     | <b>£412</b>         |

Costs associated with heat pumps (and thermal stores) have been obtained directly from manufacturers for a similar sized development. The additional costs with open-loop GSHP systems, such as the borehole pumps and specialist sensors are based on Hodkinson Consultancy cost data from other developments.

It is acknowledged that replacement costs associated with heat pump systems can vary substantially depending on which similar site or manufacturer the information has been obtained from. However, it is worth reiterating the scale of difference between all heat pump scenarios and the proposed direct electric heating set-up. Even a significant deviation from these costs would still show the proposed set-up to be more cost-effective to residents. For instance, should costs for heat pumps be at a much lower £200/kW, this would reduce the replacement costs by £90-£100/dwelling/yr in each option. Whilst a substantial reduction to the total costs, direct electric still compares favourably.

Other high capital costs items such as the initial borehole works (and associated surveys) have not been accounted for in the replacement cost analysis. This also applies to heating network pipework, which has a minimum estimated lifespan of 30+ years and is therefore considered too long to warrant being included within the replacement fund.

## Maintenance Cost Assumptions

It can be seen from Figure 1 that maintenance costs for a network of 209 connections for all heat pump scenarios are relatively high. Further detail is provided below as to the key components which cause this.

### Key Maintenance Costs

The most significant elements include:

- HIUs – Typically subject to a planned maintenance check every two years. Based on operational cost data from a number of schemes this averages out at around £50/yr/dwelling;
- Heat Pumps – Estimated at 3-5% of capital costs per year (of the heat pump installation), based on advice from several manufacturers. At the upper end this would result in costs of £85/yr/dwelling for air source systems;
- Supporting maintenance for WSHP and GSHP scenarios – In addition to the maintenance requirements of the heat pumps and common network infrastructure (such as pumps, HIUs etc), the WSHP and GSHP scenarios will also incur maintenance costs associated with the following items:
  - Additional pump sets (for flow control of water flow from underground water source or river body);
  - Manual cleaning of filters (costs obtained for a similar scheme showed these to be in the region of £50-60/yr/dwelling);
  - Further control and sensor systems, which will be higher for open-loop GSHP than WSHP systems.