Memo: Vastern Road energy strategy – updated review

Introduction

The following memo provides Reading Borough Council (RBC) with an updated review of Hodkinson's energy strategy for the Vastern Road development.

Hodkinson's original energy statement "Vastern Road – Energy Statement – HC Final v3" (Dec 2019) for the Vastern Road development was reviewed by Element Energy in June 2020. Concern was highlighted regarding the deployment of a direct electric heat supply, which could increase the cost of heat for dwelling occupants over other more efficient and lower-carbon heat generation technologies. In addition, the energy strategy did not comply with RBC policy as:

- There is no decentralised energy system,
- There is no use of heat pump technology,
- The development is not prepared for connection to a future DH network in Reading town centre.

Hodkinson provided further evidence to support the deployment of direct electricity heating ("Vastern Road – Energy Strategy, response to Element Energy – HC v3 Final", July 2020), as requested by Element Energy. Additional evidence to support the position that the direct electric strategy leads to lower costs of heat for residents was also provided by Hodkinson to Element Energy on request ("Vastern Road – Energy Strategy Further Cost Breakdown – HCv2 – 04.09.2020").

Assessment of Hodkinson's proposed strategy

The proposed energy strategy remains non-compliant with RBC policy regarding decentralised energy supplied by heat pump technology, and district heating (DH) connection readiness, as noted in Element Energy's original review. The following subsections provide further details on other aspects of the energy strategy that should be revisited in relation to policy compliance.

Proposed revisions to Part L of the Building Regulations

It was noted by Element Energy previously that certain aspects of the proposed future revision to Part L of the 2013 Building Regulations were being cherry-picked by Hodkinson to suit the direct electric strategy. The grid carbon emission factor from the latest SAP 10.1 methodology, which is yet to be adopted in the Building Regulations, was used by Hodkinson in their analysis, whilst the proposals surrounding primary energy targets were ignored. Whilst these targets have not yet been fully outlined by central government during consultation over Part L, a fair assessment of the direct electric strategy would consider the potential implications on primary energy, as well as on carbon considering the latest SAP 10.1 methodology. This would ensure the development employs the best heating solution to meet proposed changes to the Building Regulations.

Hodkinson stated ("Vastern Road – Energy Strategy, response to Element Energy – HC v3 Final") that: "***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… [meet the target].***" On a primary energy basis a decentralised communal heat pump approach is preferable over the direct electric strategy.

Hodkinson have provided evidence to support the claim that the direct electric strategy is more cost-effective for residents than a communal heating system. This is in response to another proposed change to Part L of the Building Regulations, that will require developers to demonstrate their energy strategies' expected costs of heat for residents. This is specifically designed to avoid use of direct electric heating strategies, which in principle are higher cost for residents than communal heating systems.

The following section provides an assessment of Hodkinson's comparative analysis of the direct electric strategy versus various communal network heat pump solutions.

Communal heat pump alternative comparison

Summary of Hodkinson's analysis

The costs of heat as calculated by Hodkinson are provided in Figure 1, showing the communal heat pump solutions are higher in annual costs for consumers than the direct electric strategy. Whilst the variable cost of fuel is significantly higher when employing direct electric heating compared to the heat pump cases (due to the much larger efficiencies of the heat pumps versus direct electric units such as panel and immersion heaters), the maintenance and plant replacement requirements represent high annual costs incurred by the resident. Hodkinson's analysis shows that a communal heating network with heat pumps as the primary heat supply could represent ~40-70% higher annual costs for residents than the proposed direct electric strategy. This is clearly significant and therefore warrants examination of the details of Hodkinson's analysis.

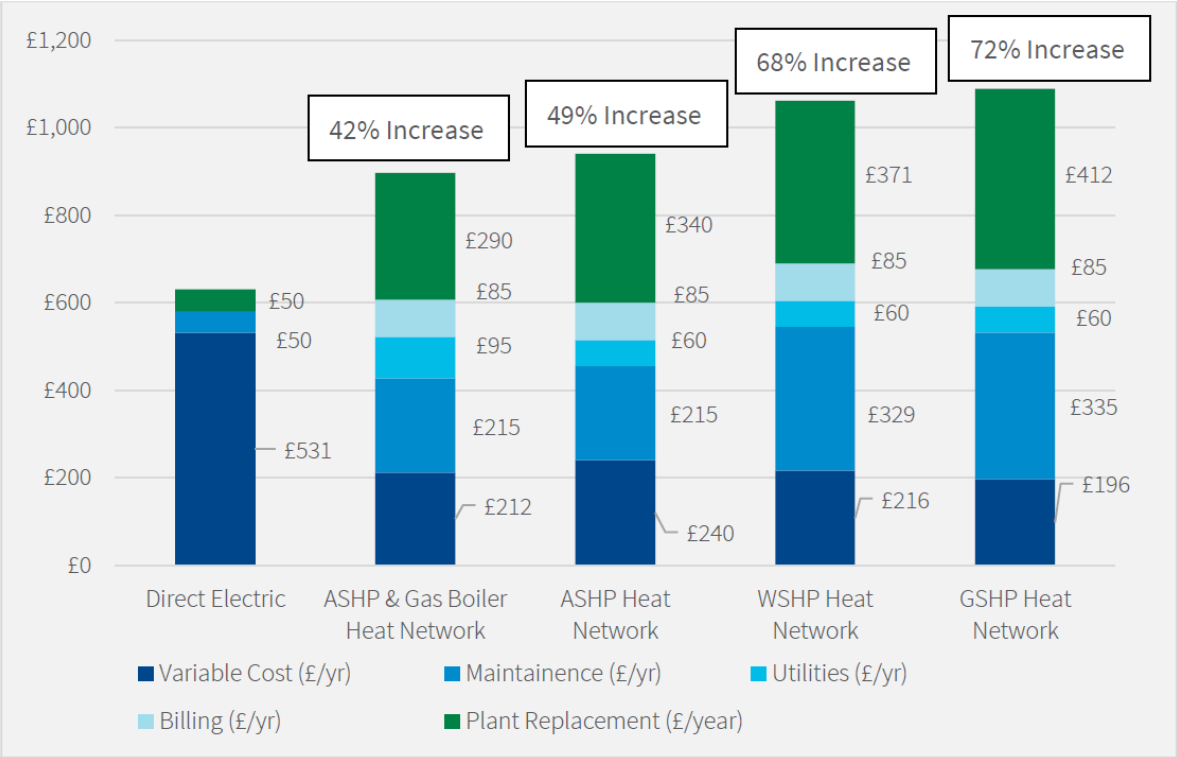

Figure 1 Estimated resident heat costs

It should be noted that Element Energy's original report included a request for the following, which have not been provided by Hodkinson:

- Spreadsheet breakdown of the cost assumptions for the direct electric and communal heat pump strategies,

- Provision of evidence that underfloor heating systems in new developments have not been positive due to lower temperatures of heat delivered to dwelling spaces (underfloor heating allows for lower temperature communal networks),
- Justification for expected O&M and billing costs for communal networks, which may be provided in the form of a network operator's contracted costs for a previous development (or equivalent information).

These should be provided to Element Energy for further review. The below assessment considers the information made available by Hodkinson to date.

Element Energy assessment of Hodkinson analysis

This assessment stress-tests the assumptions made by Hodkinson in their analysis, to understand whether the communal heat pump systems could compare favourably against direct electric heating under different conditions and cost inputs. Note this assessment does not consider the ASHP + gas boiler case as the use of natural gas heating contravenes RBC policy and potentially locks the Vastern Road development into continued use of on-site fossil fuels.

Variable cost

Electricity tariff

The variable cost constitutes the variable fraction of electricity import tariffs. Electricity tariffs used by Hodkinson were provided as follows:

- Direct electric = 16.6p/kWh,
- Communal heat pumps = 13.5p/kWh.

The 16.6p/kWh tariff roughly correlates with what would be expected for supply to "Residential" properties (BEIS "Updated energy and emissions projections: 2018" (May 2019)[1]).

The 13.5p/kWh for communal heat pumps is high relative to the BEIS figures for "Services" (i.e. non-Residential and non-Industrial electricity supply) of 11.1p/kWh. This lower tariff has therefore been applied in place of Hodkinson's original tariff.

Distribution loss factor

A distribution loss factor (DLF) of 1.5 was applied by Hodkinson, in line with CIBSE Heat Network Code of Practice CP1 requirements. Hodkinson has also stress-tested a DLF of 1.2. This assessment also stress-tests with a DLF of 1.2.

Revised variable cost

Original and revised variable costs for communal heat pumps are provided in Table 1, considering the above changes.

Table 1 Original and revised variable costs for heat pumps

Option	**Original annual variable cost per dwelling at 13.5p/kWh and DLF of 1.5**	**Revised annual variable cost per dwelling at 11.1p/kWh and DLF of 1.2**
ASHP (incl. thermal stores)	£240/yr	£158/yr
WSHP (incl. thermal stores)	£216/yr	£142/yr
GSHP (incl. thermal stores)	£196/yr	£129/yr

[1] **Annex M: Growth Assumptions and Prices**: https://www.gov.uk/government/publications/updated-energy-and-emissions-projections-2018

Maintenance cost

Annual maintenance costs are assumed as 3-5% of capital costs for heat pump units, as provided to Hodkinson by manufacturers. Hodkinson use the upper end (5%) to calculate annual maintenance costs. This assessment uses the middle value (4%), as shown in Table 2 below. A 3% maintenance cost would reduce this further to £52/yr for each heat pump option.

It should also be noted that the capital cost for heat pumps is at the higher end (£986/kWth, back calculated from evidence provided by Hodkinson in lieu of more detailed breakdown of costs). Until further evidence is provided on the source of data this assumption will remain the same for Element Energy's assessment.

Table 2 Original and revised annual maintenance costs for heat pumps

Option	**Unit capital cost**	**Original annual maintenance cost per dwelling at 5% of capex**	**Revised annual maintenance cost per dwelling at 4% of capex**
ASHP (incl. thermal stores)	£360,000	£85/yr	£69/yr
WSHP (incl. thermal stores)	£360,000	£85/yr	£69/yr
GSHP (incl. thermal stores)	£360,000	£85/yr	£69/yr

Utility cost

There are no suggested changes for the utility costs until further evidence is provided by Hodkinson.

Billing cost

There are no changes suggested for the billing costs until further evidence is provided by Hodkinson.

Plant replacement cost

The plant replacement costs for the communal heat pump systems are the most significant in Hodkinson's analysis. A table of equipment capital costs and life expectancy, which define annual plant replacement costs, have been provided by Hodkinson. These show life expectancies of 12.5-20 years, depending on the equipment in question. In practice a communal heating system operator may seek to extend the life of key plant beyond a manufacturer's quoted lifetime.

For this reason and within this assessment all equipment has been given a life expectancy of 20 years. This changes the plant replacement annual costs, as given in Table 3.

Table 3 Original and revised plant replacement costs for heat pumps

Option	**Total equipment capex**	**Original annual plant replacement cost per dwelling, variable equipment life expectancies**	**Revised annual plant replacement cost per dwelling, 20-year equipment life expectancies**
ASHP (incl. thermal stores)	£956,500	£340/yr	£229/yr
WSHP (incl. thermal stores)	£986,500	£371/yr	£236/yr

GSHP (incl. thermal stores)	£1,052,500	£412/yr	£265/yr

Further considerations

Operating temperatures

The temperature regime assumed by Hodkinson for the communal heat pump options has not been stated, however it is assumed it is >55°C to ensure domestic hot water (DHW) can be provided whilst avoiding issues surrounding Legionella in hydraulic systems. The heat pump efficiencies stated, in particular the WSHP and GSHP options, are considered to be slightly on the low side, which could be a function of the higher flow temperature (heat pumps are more efficient at lower flow temperatures). These efficiencies could be improved via an alternative temperature regime (e.g. 45°C for space heating where all dwellings have underfloor heating installed, with a direct electric DHW boost within each property), however it is acknowledged that this would likely change the capital costs stated by Hodkinson, thus meaning these changes would not provide a fair comparison with the direct electric strategy.

The operating temperatures are therefore maintained as per Hodkinson's analysis, with a caveat that improvements to the heat pump efficiencies may be possible with alternative system designs.

Results and discussion

The results of the above assessment are provided in Figure 2. All communal heat pump options remain higher cost than the direct electric strategy proposed by Hodkinson, however the differences are significantly reduced, by at least half in all cases. The ASHP option has only a 16% higher annual heat cost than direct electric, relative to 49% from Hodkinson's analysis. With reasonable and justifiable changes to the assumptions made, the communal ASHP option looks much more reasonable relative to the direct electric strategy. Further changes could be investigated once sources of data are provided by Hodkinson (e.g. manufacturer costs for heat pump units, which are considered to be on the high side in their analysis).

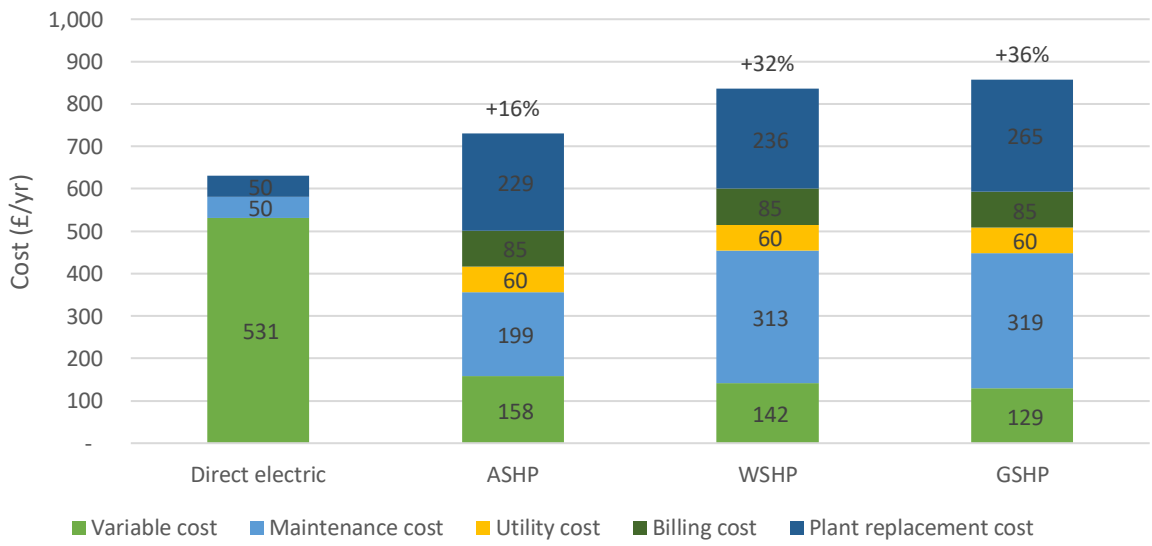

Figure 2 Revised analysis of annual cost of heat for Vastern Road residents

The design of the dwellings is such that they achieve very high thermal performance and thus demand reductions, with Hodkinson demonstrating through SAP analysis that some of the dwellings are

expected to achieve as low as ~16 kWh/m^2/yr space heating demand, which is close to Passivhaus standard (note the average for the development is 28 kWh/m^2/yr, however this can also be considered a very low space heating demand). A communal heat network necessitates that a minimum volume of heat is demanded to pay back the equipment and infrastructure installed to support it. With a very low heat demand, as is expected for Vastern Road, the pay back for the equipment and infrastructure is more challenging.

Given the large difference in equipment efficiencies, increases in heat demand lead to better cost performances from the heat pump options versus the direct electric strategy. Even an increase of just 10% in demand would reduce the difference in cost of heat between the direct electric strategy and communal ASHP option from the 16% shown in Figure 2 to 9%. Conversely, if demand were to be lower the opposite effect would occur (although modelled demand is very low presently so potential for further reductions in demand beyond those modelled by Hodkinson are not expected).

The significant heat demand reduction through a "fabric first" approach is welcomed by Element Energy, but it should be acknowledged that the SAP methodology often leads to what is known as the "performance gap", i.e. the difference in modelled versus as-built energy consumption, which can often lead to higher costs for consumers than expected.

Discussion and recommendations

It may be surprising that the direct electric strategy remains more cost-effective for consumers on Vastern Road even given the stress-testing conducted in this assessment. However, given the inputs and assumptions for this type of cost analysis are highly variable (in the case of Hodkinson's analysis, they appear to be on the high side), the difference in cost of heat should not be the main driver in determining whether the proposed development should be granted planning permission with the current energy strategy. This should be determined by whether the energy strategy complies with current and proposed near-future local and national policy.

Hodkinson are required to provide further evidence to support their analysis, as was requested in Element Energy's original review:

- **Spreadsheet breakdown of the cost assumptions for the direct electric and communal heat pump strategies,**
- **Provision of evidence that underfloor heating systems in new developments have not been positive due to lower temperatures of heat delivered to dwelling spaces (underfloor heating allows for lower temperature communal networks),**
- **Justification for expected O&M and billing costs for communal networks, which may be provided in the form of a network operator's contracted costs for a previous development (or equivalent information).**

Once this further information is received, it will be clear whether the other requirements requested of Hodkinson by Element Energy's original review need to be revisited. These include revising the calculated zero-carbon homes offsetting payments; further investigation of open-loop GSHP and WSHP technical potential.

Regardless of the cost of heat for residents and proposed changes to the Building Regulations, the current Vastern Road energy strategy is not compliant with RBC's policy regarding district heating (DH) connection readiness. Given the development is in a priority area for DH, RBC may wish to mandate a decentralised heating system to be compatible with any future network that comes online. The above analysis shows this may increase annual heat costs for residents, however this should be balanced

against the types of occupants expected in these new homes. An additional £100/yr cost of heat for residents of high-quality luxury homes, as are planned for Vastern Road, may not be a priority for RBC in relation to sustainability requirements for Reading.

It is recommended that the planning and sustainability departments of RBC agree on the priority for this development with regard its DH connection readiness and the potential impact this may have on prospective occupants of Vastern Road.