

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).

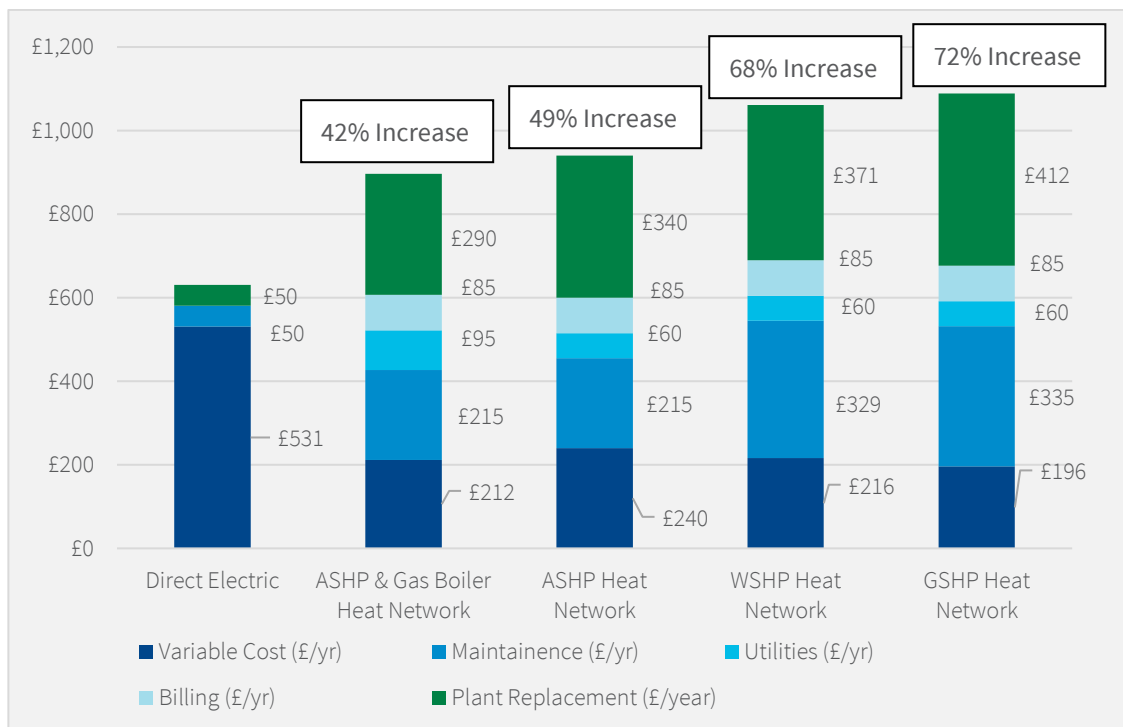
Element Energy have requested supporting calculations, with specific reference to the following:

- > 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
Common Plant (in all scenarios)			
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
Total	£571,500		£45,347
Total per Dwelling	£2,748		£217
ASHP / Gas Boiler Hybrid			
ASHPs (inc. thermal stores)	£200,000	15	£13,333
Gas Boilers	£40,000	20	£2,000
Total	£240,000		£15,333
Total per Dwelling	£1,154		£73
ASHP Only			
ASHPs (inc. thermal stores)	£360,000	15	£24,000
Supporting Electricals	£25,000	15	£1,667
Total	£385,000		£25,667
Total per Dwelling	£1,851		£123
WSHP			
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
Total	£415,000		£32,217

Total per Dwelling	£1,995		£154
GSHP (Open-Loop)			
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
Total	£535,000		£40,717
Total per Dwelling	£2,572		£195

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)

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

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.