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# Reading Heat Network Technoeconomic Feasibility Study

Reading Heat Network DPD

Reading Borough Council

Project number: 60737642

April 2026

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## Quality information

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# 1. Introduction

The purpose of this report is to supplement the appended Minster Quarter Feasibility Study. This report outlines the development of the analysis undertaken between the Feasibility Study and the Economic Case. The Minster Quarter Feasibility Study considered a network within a Red Line Boundary encompassing the Minster Quarter Central Development area and some parts of the Town Centre. Opportunities for wider network expansion arose from additional heat offtakers – principally the Royal Berkshire Hospital. Consequently, analysis pertaining to the feasibility study has been refreshed in the DPD and outlined in the Economic Case – this report summarises this analysis and provides a link between this and the original Feasibility.

## Methodology

The Feasibility Study is the output of the second phase of the development of the Reading Heat Network.

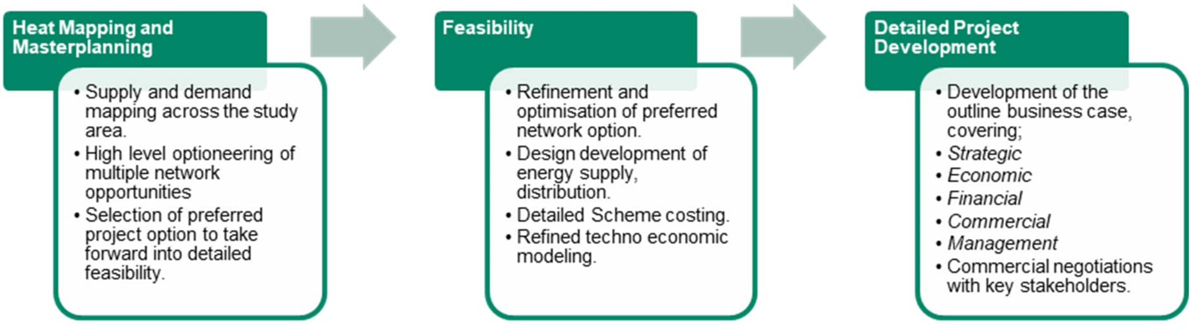


**Figure 1: Heat mapping to DPD methodology**

The following methodology has been applied for the Feasibility Study, building on the previous Heat Mapping Study and Feasibility for the North of Station cluster.

- **Step 1 - Refinement and optimisation of preferred network option.**

The selected option(s) were developed further, with the scheme designs being refined with improved data granularity. This refinement encompassed aspects such as the plant, thermal storage and pipe sizing. Further enhancement of hourly energy profiles informed detailed modelling of the energy centre plant. This exercise provides greater certainty on cost and performance as well as optimising projected carbon savings and returns on investment.

- **Step 2 - Design development of energy supply, distribution.**

The initial design from the previous stage was refined to include all aspects of the energy centre (EC) up to RIBA Stage 2. As part of this, further work to de-risk the heat source using appropriate specialists was undertaken. At this stage, the factors influencing the energy centre design and selection of energy source(s) (both primary and back-up) and energy storage considered under HMMP were re-evaluated, including current and future $CO_2$ emissions, capital and operating costs, maintenance requirements, risks, constraints, utility infrastructure, spatial requirements and eligibility for Green Heat Network Fund (GHNF) funding.

- **Step 3 - Refined techno economic modelling.**

A techno-economic model was employed to define the optimum heat network project. Both technical and financial input data was revised based on new information and additional assessment. Sensitivity tests were conducted to understand the impact of different factors on the project's financial and environmental performance.

The subsequent diagram summarises the methodology of the Feasibility Phase.

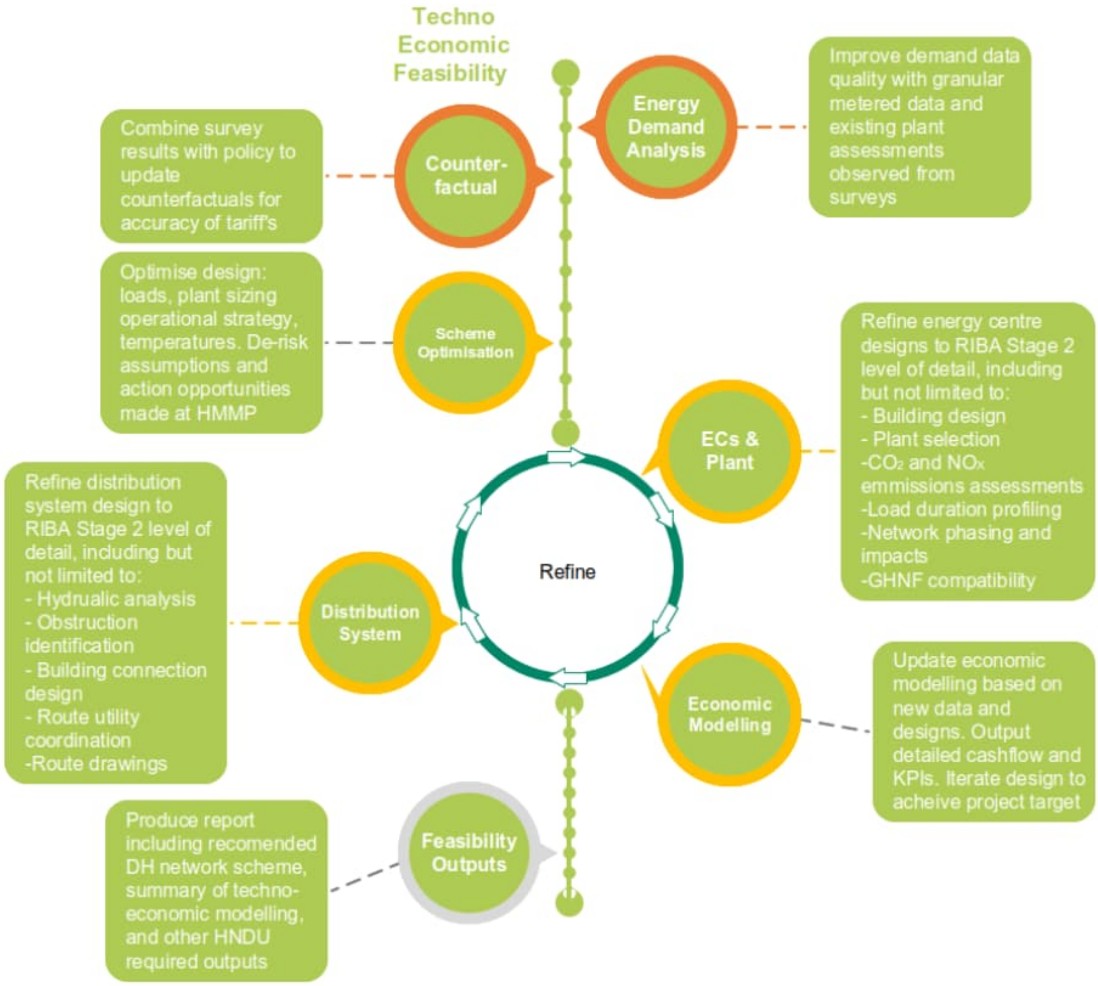


**Figure 2: Detailed feasibility methodology**

# 2. Changes from Feasibility to DPD (Economic Case)

A detailed overview of the long list, short list, scoring, and revision of Preferred option is available in the Economic Case. The core change between Feasibility and Detailed Project Development is the integration of the London Road Cluster as shown in Figure 3.

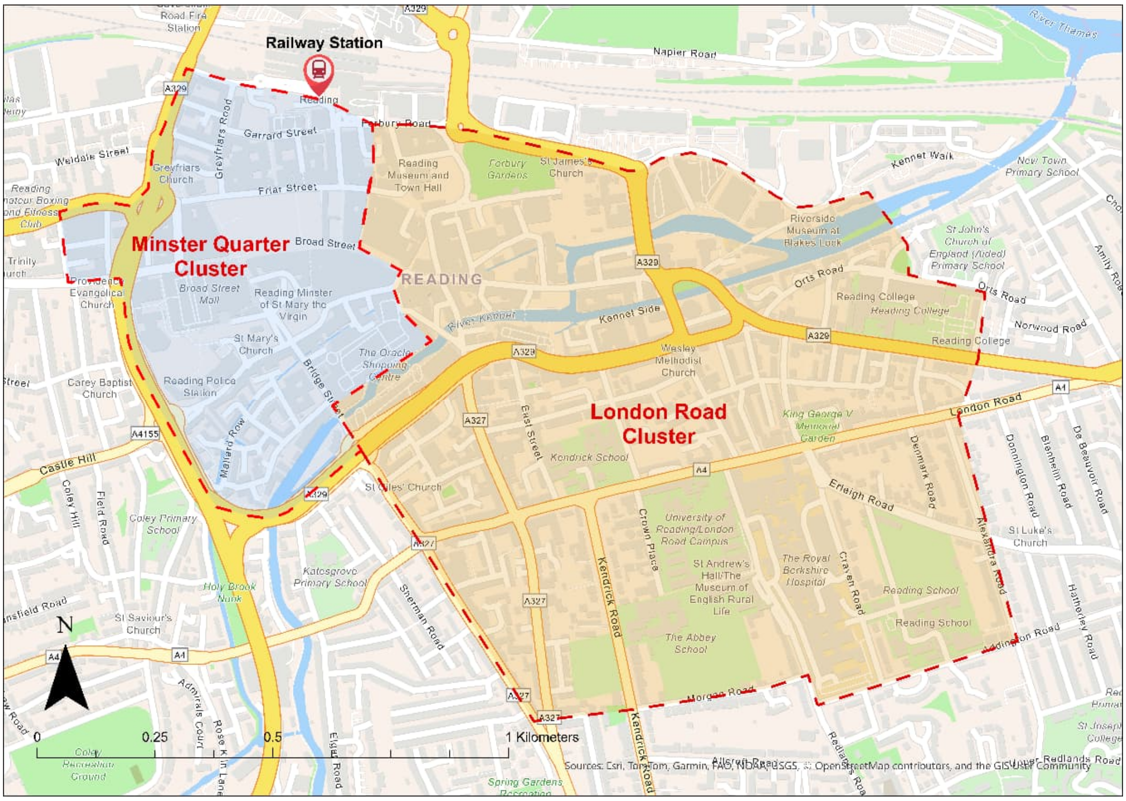


Figure 3: Red Line Boundary for DPD

As part of the DPD, the list of potential heat network connections has been reviewed and expanded beyond those considered in the Minster Quarter Feasibility Study. While several of the offtakers included within the DPD study were already assessed at feasibility stage, the extension of the study area to include the wider London Road cluster has resulted in the identification of additional connections.

These newly identified offtakers have been incorporated into the scenario modelling to reflect the revised network boundary and updated understanding of potential connection opportunities. This includes both existing buildings and key institutional and residential sites that were not previously within the feasibility study boundary.

Anchor loads are defined as buildings or sites with consistent and substantial heat demand above a threshold of 500 MWh per year) that are expected to connect early to the heat network. These sites play a critical role in underpinning the financial and technical viability of the scheme by providing a stable base demand and are typically aligned with organisations that have clear decarbonisation commitments or obligations.

The anchor loads proposed for connection, alongside all other potential offtakers considered within the DPD study, are shown in Figure 4, which presents the full extent of heat demands assessed within the revised network boundary.

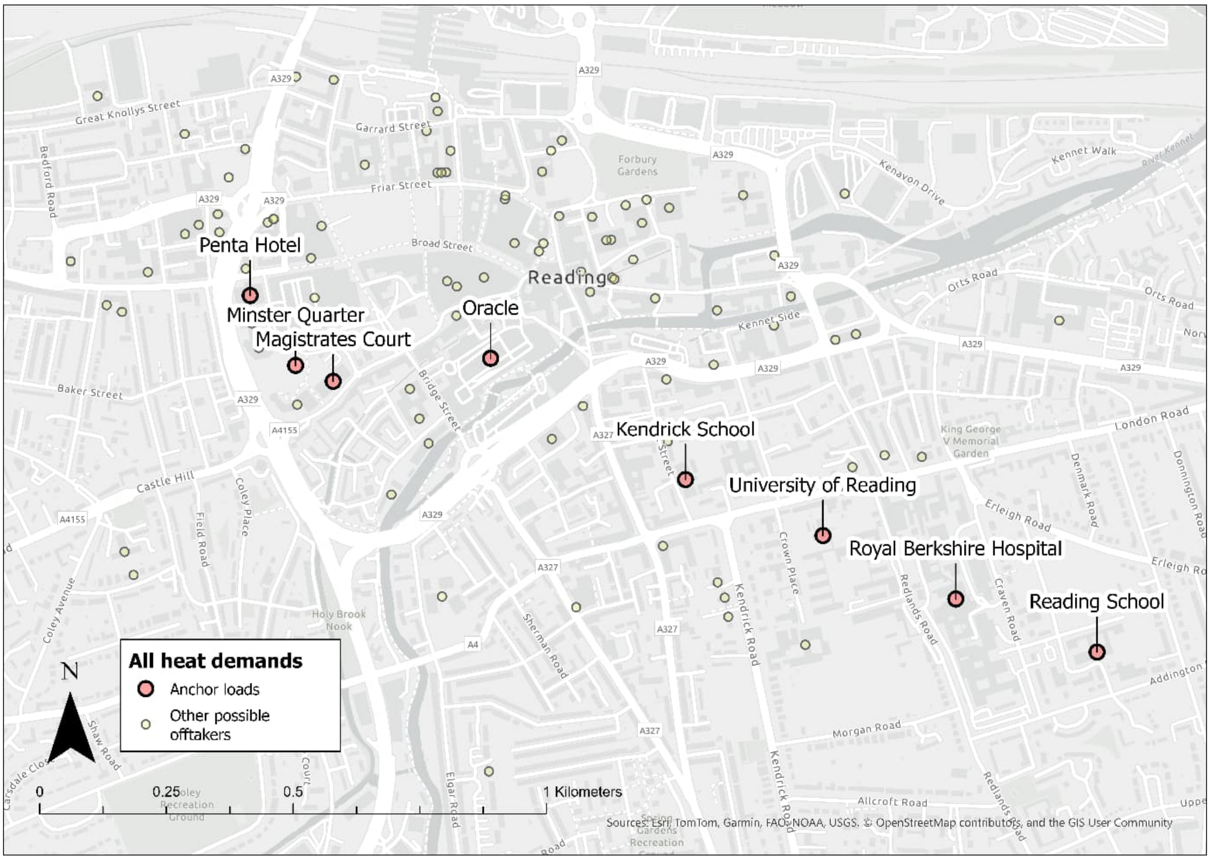


**Figure 4: All heat network connections – anchor loads and other possible offtakers**

The key characteristics of previously assessed and newly identified offtakers are summarised in Table 1.

**Table 1: Previously identified offtakers and additional offtakers identified at DPD**

| Reading Heat Network Loads | New at DPD | Existing / Future / Redevelopment | Resi / Non-Resi / Mixed |
|---|---|---|---|
| Penta Hotel | No – included at feasibility | Existing | Non-Resi |
| MQ Redevelopment | No – included at feasibility | Redevelopment | Mixed |
| Magistrates Court | No – included at feasibility | Existing | Non-Resi |
| Oracle Development | No – included at feasibility | Redevelopment | Mixed |
| Kendrick School | Yes | Existing | Non-Resi |
| University of Reading | Yes | Existing | Non-Resi |
| Royal Berkshire Hospital | Yes | Existing | Non-Resi |
| Reading School | Yes | Existing | Non-Resi |
| Town Hall | Yes | Existing | Non-Resi |
| John Lewis Store | Yes | Existing | Non-Resi |
| Visa Offices | Yes | Existing | Non-Resi |
| Homes for Students Kendrick Hall | Yes | Existing | Resi |
| Aparto Student Accommodation | Yes | Existing | Resi |

Further key developments undertaken during the DPD stage are summarised below:

- Assessment of heat demand for all proposed offtakers revised since feasibility, including additional non shortlisted sites. The full list of potential connections has been revisited and updated to reflect the expanded study area, with heat demand assessments completed to provide a consistent basis for network development

- Evaluation of energy supply options with a focus on the River Kennet. A detailed review of available low carbon heat sources has been undertaken, with particular emphasis on the feasibility and role of heat extraction from the River Kennet in supporting the proposed network. A dedicated River Source feasibility study was also commissioned alongside the DPD to further assess technical viability and inform the preferred supply strategy.

- Further evaluation of energy centre location options. At DPD stage, the preferred location for the main River Energy Centre has been identified at Queen's Road Car Park, representing a new proposed energy centre site. The car park includes underutilised space near the entrance that can be repurposed for energy centre use, including provision for thermal storage and electrical infrastructure, with the multi-level structure offering flexibility for plant arrangement across floors. The McLaren energy centre location was previously identified at feasibility stage and has been retained as part of the wider options assessment. Contingency options have also been considered, including potential relocation to the Magistrates Court or an alternative site near the Oracle Centre roundabout should constraints arise.

- The heat distribution network has been reviewed and refined to reflect the expanded list of offtakers and revised spatial constraints. This includes reassessment of routing options and connection sequencing across both the Minster Quarter and London Road clusters.

- Early-stage modelling has been undertaken to test the revised network configuration incorporating updated heat demands, supply assumptions and infrastructure layouts to assess overall scheme performance and viability at DPD stage.

- Interim findings assumptions and emerging conclusions have been consolidated and presented through a structured slide deck to support stakeholder engagement and decision making during the DPD process.

All heat sources shortlisted at DPD are shown below in Figure 5.

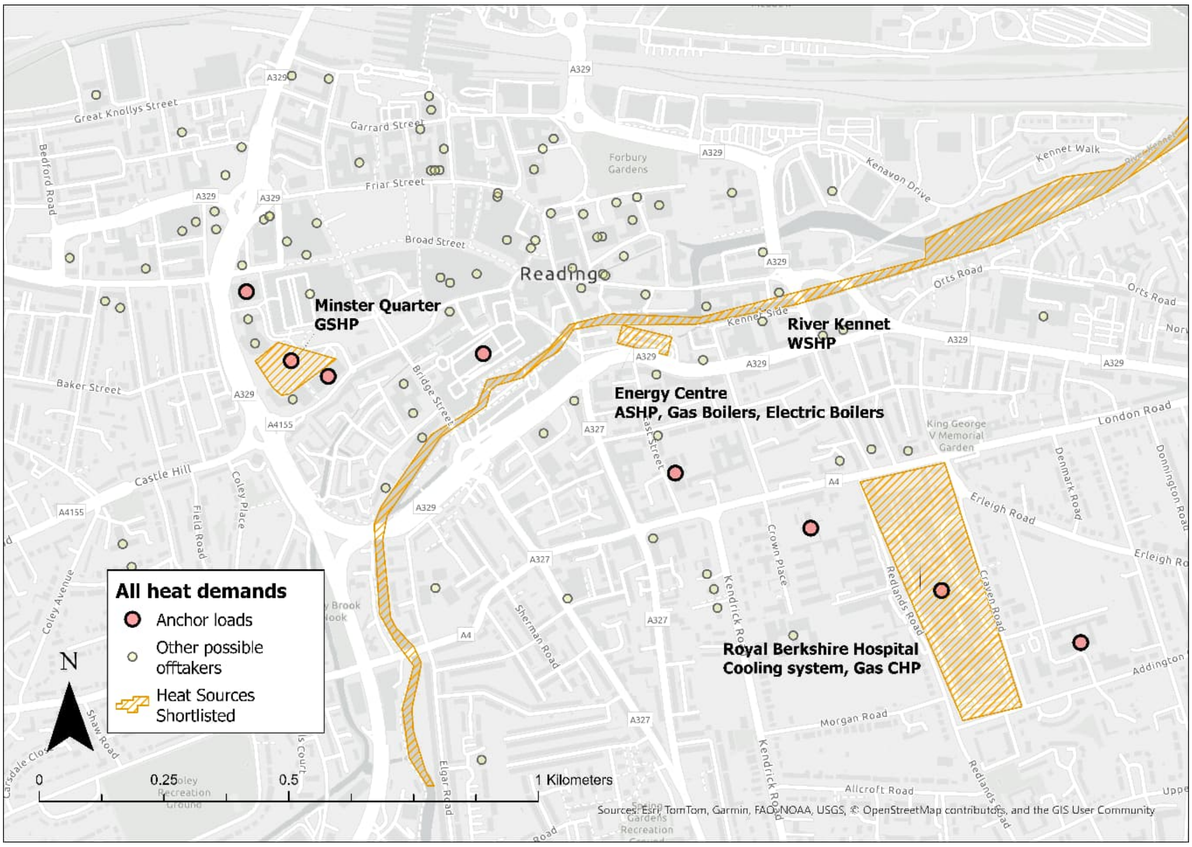


Figure 5: Shortlisted heat sources and all possible offtakers

# Feasibility Shortlist

The options assessed in this study originate from the option development undertaken as part of the Reading DPD. Section 3 of the Economic Case documents the long list assessment, which explored the full range of options for network extent, customer loads, heat sources, and energy centre locations, leading to the identification of a shortlist of deliverable configurations for detailed appraisal. Option 0 is defined as the counterfactual scenario and represents the alternative decarbonisation pathways that customers may reasonably pursue in the absence of a heat network. Options 1 to 6 comprise the core heat network configurations carried forward from the DPD assessment, while Options 7 to 9 are sensitivity scenarios included to test the resilience of the results to changes in key assumptions. Option 0 – Counterfactual

Each of the shortlisted heat network options are compared against a counterfactual case. This counterfactual considers the alternative decarbonisation option that would be pursued by future customers were they not to connect to the network. This is instead of the comparison to the ongoing use of gas boilers, which is deemed the Business as Usual. While the use of gas boilers is currently permissible, future policy change is anticipated over the next 10-15 years to incentivise the switch away from gas boilers to high efficiency, electrified heating systems. This analysis seeks to compare low carbon heating solutions to one another to help inform on which route Reading Council should take for its future heating requirements (i.e. a heat network or individual building solutions). For some buildings, the Counterfactual is still gas boilers – those deemed most at risk – existing residential properties.

## Option 1 – All Core, River and Ground

This option considers all offtakers designated as Anchor Loads – those with the highest engagement or connection probability. These are the Royal Berkshire Hospital, Kendrick School, the University of Reading, Reading School, Penta Hotel, Magistrates Court, and the Minster Quarter Central and Oracle Developments.

Option 1 considers these loads, connected to the best scoring heat sources and energy centre locations – River Source, delivered from an Energy Centre at the Queen's Road Car Park, and Ground Source, delivered from boreholes to an Energy Centre at the Minster Quarter Central Development site. The configuration in this option would be 3.5 MW of River Source, 0.8 MW of Ground Source, and 16.2 MW of backup Gas boilers.

## Option 2 – All Core + Additional, River and Ground

Option 2 extends Option 1 to connect to the offtakers deemed as "Additional" – these are smaller offtakers or those with which engagement is more complex. Alongside the above, this includes the Town Hall, John Lewis store, Visa Offices, Kendrick Hall Student flats, and the Aparto Student Accommodation.

The option requires the same Energy Centre locations and heat sources but requires more low carbon heat to meet the required contribution across the year – 5MW of River Source and 0.8MW of Ground Source, with 18.9MW of backup boilers.

## Option 3 – Minster Quarter, Ground and Air

The Core Minster Quarter scheme was the basis for the Feasibility Study preceding this Business Case. This Option considers connection to the Minster Quarter Central development and a limited number of nearby buildings – the Minster Quarter and Oracle Developments, the Penta Hotel, and the Magistrates Court. The heat network would require 7.4GWh of heat annually, supplied by 0.8MW of Ground Source heat pumps, 0.1MW of Air Source, and 3.8MW of backup gas boilers at the Magistrates Court.

## Option 4 – Minster Quarter + Additional, Ground and Air

Option 4 considers extending the Minster Quarter opportunity to further heat customers. These are the Town Hall, the John Lewis store, the Visa Offices, Kendrick Hall student flats, and the Aparto Student Accommodation. In this, the heat demand is increased to 15GWh per year, necessitating a Low Carbon heat supply of 0.8MW of Ground Source, 1.2MW of Air Source heat pumps, and 7.6MW of gas backup on the Mclaren site.

## Option 5 – All Core, River and Air

Option 5 considers the same network extent (offtakers) as Option 1 - the Royal Berkshire Hospital, Kendrick School, the University of Reading, Reading School, Penta Hotel, Magistrates Court, and the Minster Quarter Central and Oracle Developments. This variation has been developed to assess the impact of not pursuing a borehole option on the Minster Quarter Central site – instead considering a larger quantity of Air Source Heat Pumps on the Magistrates Court roof, alongside the Queens Road River heat.

This variation of the network would require 2.3MW of river source heat pumps, and 2.2MW of air source, with 16.2MW of backup gas boilers. The scenario considers the Magistrates Court as the location for Air Source but comes with the possibility of this source also being hosted at the Car Park – if space were to allow.

## Option 6 – All Core + Additional, River and Air

Option 6 extends Option 5 in the same manner as Option 2 extends Option 1 – extending to the Town Hall, John Lewis store, Visa Offices, Kendrick Hall Student flats, and the Aparto Student Accommodation. This extra 12.5GWh of heat demand is supported by a total 6MW of river and air source heat pumps (3MW each) and 18.9MW of gas backup.

## Option 7 – All Core, River and Ground and Air

The remaining three Scenarios are *Sensitivity Scenarios* – alterations to the above to verify the impact of some of the most major assumptions. Option 7 explores the opportunity to utilise all three of the primary low carbon heat sources – River (3.5MW), Ground (0.8MW), and Air (1.4MW). The necessity of this could stem from any number of reasons – spatial limitations in the Energy Centre, or limits on the amount of heat extractable from the river, for instance.

The option connects all "Core" buildings noted above - the Royal Berkshire Hospital, Kendrick School, the University of Reading, Reading School, Penta Hotel, Magistrates Court, and the Minster Quarter Central and Oracle Developments.

## Option 8 – All Core without Hospital, River and Ground

This Option is Option 1, with the leaving of the hospital - Kendrick School, the University of Reading, Reading School, Penta Hotel, Magistrates Court, and the Minster Quarter Central and Oracle Developments. The hospital is the largest heat demand of the network, and their withdrawal would have the single biggest impact. Without the hospital, the heat supply required is significantly smaller – 0.85MW of River, and 0.8MW of Ground required. The backup boiler required would have a capacity of 8MW.

## Option 9 – All Core, River and Air, Elec Backup

This scenario is the same as Option 5 (including capacities) with the difference being that the backup boilers are electric rather than gas. This would be to increase the carbon savings of the network and completely remove the reliant on gas of the existing buildings. This would have no impact on the heat supplied to the offtakers, or to the low carbon heat sources, but would necessitate a significantly larger electrical connection.

A summary of the Shortlist is available in Table 2.

**Table 2 - Key information for each short list Option**

| | Op1 | Op2 | Op3 | Op4 | Op5 | Op6 | Op7 | Op8 | Op9 |
|---|---|---|---|---|---|---|---|---|---|
| **Extent** | MQ + LR Anchor loads | All MQ + LR loads | MQ Anchor loads | All MQ loads | MQ + LR Anchor loads | All MQ + LR loads | MQ + LR Anchor loads | MQ + LR Anchor loads *without Hospital*[1] | MQ + LR Anchor loads |
| LC Heat Source 1 | RSHP – 3.5MW | RSHP – 5MW | GSHP – 0.8MW | GSHP – 0.8MW | RSHP – 2.3MW | RSHP – 3MW | RSHP – 3.5MW | RSHP – 0.85MW | RSHP – 2.3MW |
| LC Heat Source 2 | GSHP – 0.8MW | GSHP – 0.8MW | ASHP – 0.1MW | ASHP – 1.2MW | ASHP – 2.2MW | ASHP – 3MW | GSHP – 0.8MW | GSHP – 0.8MW | ASHP – 2.2MW |
| LC Heat Source 3 | - | - | - | - | - | - | ASHP – 1.4MW | - | - |
| Backup | Gas boiler – 16.2MW | Gas boiler – 18.9MW | Gas boiler – 3.8MW | Gas boiler – 7.6MW | Gas boiler – 16.2MW | Gas boiler – 18.9MW | Gas boiler – 16.2MW | Gas boiler – 8MW | Elec boiler – 16.2MW |
| Energy Centre Location | QR Car Park and Mclaren Site | QR Car Park and Mclaren Site | Mclaren Site | Mclaren Site | QR Car Park and Magistrate's Roof | QR Car Park and Magistrate's Roof | QR Car Park and Mclaren Site | QR Car Park and Mclaren Site | QR Car Park and Magistrate's Roof |

# Economic Appraisal

The full set of assumptions and inputs that were incorporated in the economic modelling is detailed within the Appendix G of the Economic Case. The output of the TEM, as described in the appendix, is an economic cashflow model (over a 40-year period) for each solution, from which the following metrics are derived:

- Levelised Cost of Heat (LCoH): A single value that represents a time adjusted whole life cycle cost of energy for a project over a 40-year lifespan, expressed as a single p/kWh value.
- Indicative Economic Project Internal Rate of Return (IRR): This provides an indication of the pre-tax, pre-finance, real rate of return on the investment. The TEM and Financial Model IRRs will change slightly when adjusting to nominal (factoring tax, inflation, cost of borrowing etc., see Financial Case). As this is pre-adjustment, this IRR is primarily used as a comparative metric.
- Indicative Economic Project Social Internal Rate of Return (SIRR): This shows the rate of return on the investment considering the monetarised value of the carbon saved and avoided air quality damage. The financial value of these metrics is defined by HM Treasury in the Green Book.
- Indicative Economic Project Net Present Value (NPV): This is the yield of the investment based on the capital investment and the costs and returns over time, together with the discount factor of 3.5% (Green Book standard value - the factor by which a future cash flow must be multiplied to obtain the present value).

The metrics above are termed 'economic' as they do not consider costs associated with financing the project considered separately in the Financial Case.

Table 3 provides a summary of the key technical and economic outputs:

**Table 3 - Key economic metrics for short list**

| Scenario | CAPEX (£m) | 40-year pre-grant IRR (%) | Possible Grant (£m) | LCoH (p/kWh) | SIRR (%) | Heat delivered (MWh/yr) |
|---|---|---|---|---|---|---|
| 1 | £41.1 | 4.51% | £9.48 | 14.18 | 9.83% | 30,352 |
| 2 | £49.3 | 5.75% | £13.25 | 13.05 | 12.09% | 42,892 |
| 3 | £15.3 | 1.32% | £2.62 | 16.24 | 2.39% | 7,470 |
| 4 | £20.5 | 3.64% | £4.88 | 14.01 | 7.85% | 15,014 |
| 5 | £39 | 4.65% | £9.48 | 14.14 | 10.27% | 30,352 |
| 6 | £46.9 | 5.86% | £13.25 | 13.12 | 12.58% | 42,892 |
| 7 | £43.1 | 3.50% | £9.48 | 14.86 | 9.38% | 30,352 |
| 8 | £27.1 | 0.78% | £4.07 | 18.15 | 3.47% | 12,322 |
| 9 | £42.5 | 0.44% | £9.48 | 16.7 | 7.92% | 30,352 |

NB: “Possible grant” is at this stage assumed to be 2p/kWh of heat delivered in the first 15 years of operation – the GHNF maximum value is 4.5p/kWh.

As can be seen in Table 3, the scenarios with the greatest return on investment are those capitalising on more efficient heat sources (river and ground) and those that connect to a greater number of nearby offtakers (for increased revenue against initial cost).

# Assessment of Options against GHNF Criteria

Grant funding can be a critical economic variable in assessing the viability of the options. Heat networks are significant long-term capital investments, which often require some level of grant to make the project attractive to investment. The Green Heat Network Fund is important funding mechanism that would allow the proposed scheme to progress.

The Green Heat Network fund (GHNF) is a UK government funding programme that aims to “incentivise heat network market transition to low carbon heat sources via targeted financial support, that will help stimulate the increased deployment of low carbon technologies at scale”. Initially £288 million has been set aside for the fund between 2021 and 2025; with funding available to contribute to capital and commercialisation costs. January 2026 saw a further £47m committed with scheme extension out till 2028.

The main criteria to qualify for the GHNF are that:

- The pre grant 40-year IRR must be positive;
- The pre grant 40-year SIRR must be over 3.5%;
- An emissions limit of no greater than 100gCO2e/kWh (within the first 5 years);
- A minimum of 2GWh/yr demand.

The maximum grant that can be applied for is dependent on:

- Less than 50% of the total project cost (including commercialisation);
- 15-year heat/cool forecast to not exceed 4.5p of grant per kWh delivered over 15 years.

Compliance against the first three criteria has been assessed within this techno-economic assessment with the results presented in Table 4.. All options meet the first economic criterion, whilst the thermal fraction for the gas boiler options ensures the carbon threshold is met. There is capacity to increase the carbon factor by increasing gas contribution whilst still maintaining the GHNF allowance – this would allow the consumer costs to come down if required. Options 3 and 8 do not meet the Social IRR target – though this would potentially be attainable by decreasing the gas contribution. Given the increased running costs from electric boilers and the increased capital requirement for the future grid connection, the pre-grant IRRs for the option with electric boiler back up perform considerably worse than its gas counterpart, which could affect the likelihood of accessing the grant funding.

**Table 4 - GHNF eligibility for shortlisted scenarios**

| Scenario | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 40-year IRR Pre-Grant | 4.51% | 5.75% | 1.32% | 3.64% | 4.65% | 5.86% | 3.50% | 0.78% | 0.44% |
| 40-year SIRR Pre-Grant | 9.83% | 12.09% | 2.39% | 7.85% | 10.27% | 12.58% | 9.38% | 3.47% | 7.92% |
| Carbon intensity below 100? | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Eligible for GHNF? | Y | Y | N | Y | Y | Y | Y | N | Y |

# Environmental Appraisal

The options have been assessed on their environmental impact alongside the economic appraisal above. The DESNZ Green Book has been used to estimate the future carbon intensity of grid electricity. More information on the assumptions for these calculations can be found in Appendix G of the Economic Case.

**Table 5 - Key environmental metrics for short list**

| Scenario | LZC Source | Thermal Fraction | Average 40-yr carbon factor (gCO2/kWh) | 40 yr carbon emissions (tCO2e) | Savings against gas (tCO2e) | Savings against counterfactual (tCO2e) |
|---|---|---|---|---|---|---|
| 1 | River/Ground | 80.91% | 43.3 | 54,753 | 215,710 | -46,243 |
| 2 | River/Ground | 80.13% | 44.7 | 78,882 | 298,881 | -26,813 |
| 3 | Ground/Air | 80.53% | 44.5 | 15,529 | 59,153 | -13,300 |
| 4 | Ground/Air | 81.33% | 42.6 | 27,702 | 111,521 | -7,104 |
| 5 | River/Air | 80.87% | 43.6 | 55,133 | 215,330 | -46,623 |
| 6 | River/Air | 80.26% | 44.6 | 78,843 | 298,919 | -26,774 |
| 7 | River/Ground/Air | 90.25% | 25.2 | 31,914 | 238,550 | -23,403 |
| 8 | River/Ground | 80.43% | 45.8 | 24,866 | 91,330 | -21,305 |
| 9 | River/Air | 80.87% | 8.2 | 10,363 | 260,100 | -1,852 |

The modelling verified that:

- As the grid decarbonises, the ability of a network with 20% gas contribution to meet the same carbon thresholds as counterfactuals entirely using electricity decreases.
- The larger scenarios offer the greatest carbon savings.

- GSHP and RSHP generally perform better than ASHP in carbon emissions terms.

# Comparison of Options/Scoring

The Council has agreed upon a series of Critical Success Factors (CSFs) against which the shortlist has been scored. The CSFs are comprised of **qualitative** and **quantitative** assessments:

Qualitative assessments employ a pass/fail mechanism, or a ranking on perceived ability to meet the objectives in comparison with one another.

Quantitative assessments and scoring were undertaken on a similar 1 (low) to 5 (high) scale, using the relevant metrics such as IRR and price of heat, p/kWh, to compare options. The best performing scenario scored a 5 and the lowest a 1, linear interpolation is then deployed to determine the value for the remaining scenarios. A weighting factor (out of 100) has been assigned to each CSF to reflect the relative importance in the overall project rating.

Based on the analysis, modelling, and the scoring methodology above, the scoring of each shortlisted options is shown in Table 6.

**Table 6 - Short List Scoring**

| Number | Loads | Heat Source | Score |
|---|---|---|---|
| 1 | Anchor | River/Ground | 3.24 |
| 2 | All | River/Ground | 3.74 |
| 3 | MQ Anchor | Ground/Air | 2.04 |
| 4 | MQ All | Ground/Air | 2.78 |
| 5 | Anchor | River/Air | 3.20 |
| 6 | All | River/Air | 3.69 |
| 7 | Anchor | River/Ground/Air | 2.78 |
| 8 | Anchor without Hospital | River/Ground | 1.78 |
| 9 | Anchor | River/Ground/Elec BU | 2.29 |

**Option 2 – Ground and River scheme with all possible offtakers, scores the highest**. The scenario benefits from two low carbon heat sources, the maximum amount of revenue attainable from the considered short list of offtakers, and the potential cooling opportunities associated with Ground Source and new developments. Unlike the Air Source scenarios, there is an additional risk associated with needing land on the Minster Quarter Central site for an Energy Centre. This should be managed proactively through open dialogue with Mclaren as the project progresses.

# Performance of Preferred Option

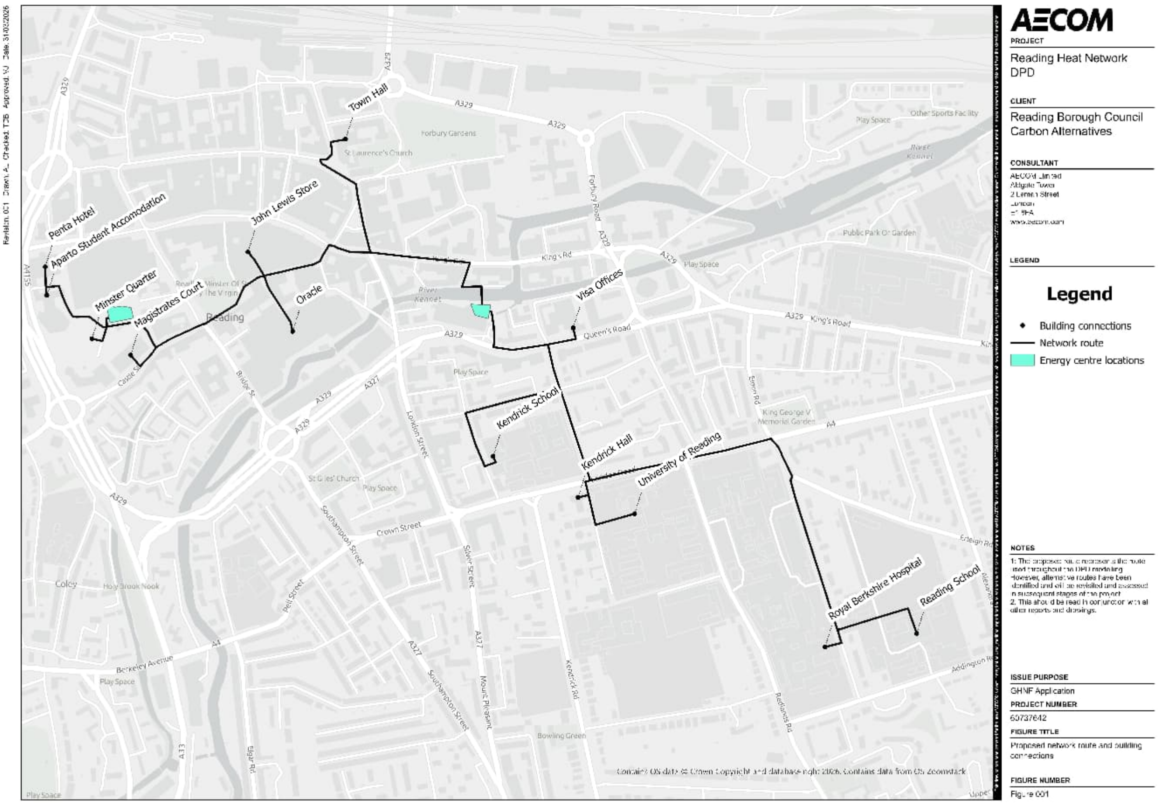


**Figure 6 - Preferred Network Route**

The Preferred Route is shown in **Figure 6 - Preferred Network Route**. Following the further refinement of the Preferred Option as outlined above. The TEM has been updated to take account of the following changes:

- Route changes and cost alterations for pipework to account for uncertain crossings and high-density traffic areas;
- Updated plant performance as per manufacturer data sheets;
- Updated costing for major thermal generating equipment of gas boilers, river source heat pumps and ground source heat pumps;
- Alteration of assumed revenue (reduction in tariffs for offtakers and reduction in some connection fees);
- Cost estimates derived through the development of the energy centre design and specification of floor area.

Table 7 shows that the changes in the network performance that has occurred because of the net increase to the capital cost, and reduction in revenue – however the carbon performance of the network has improved due to the increase in efficiency of the equipment proposed by manufacturers.

Note – there is head room in the current carbon intensity to utilise a higher proportion of gas. This could come by reducing the size of the river source heat pumps (or simply prioritising gas consumption at specific times). The benefit of this is economic – the carbon threshold being maintained at a higher level but one that falls within grant requirements would allow a total reduction in the cost of fuel, which could then be passed on to customers to ensure the scheme remains an economically attractive prosect. The level to which offtakers find this agreeable will be explored at commercialisation.

**Table 7 - Preferred Option key output parameters**

| Metric | Unit | Value |
|---|---|---|
| Annual Heat demand (full build out) | MWh | 45,306 MWh |
| Low/Zero Carbon heat source Contribution | % | 90% |
| Total network length | m | 3,794m |
| 40-year total Carbon savings against counterfactual | Tonnes $CO_2$ | 4,232 Tonnes |
| 40-year total Carbon savings against gas | Tonnes $CO_2$ | 311,178 Tonnes |
| 40-year carbon intensity | $gCO_2$/kWh | 26.8g |
| Maximum carbon intensity | $gCO_2$/kWh | 52.7g |
| Capital Cost | £m | £54.6m |
| 40-year IRR | % | 3.47% |
| 40-year SIRR | % | 9.98% |
| 40-year NPV | £m | £15.89m |
| 40-year SNPV | £m | £48.70m |

# 3. Technical Design

## Thermal Storage sizing

To appropriately size the network's thermal storage, the average hourly heat demand was analysed over the full annual period. For each hour, the available low-carbon heat sources, comprising excess heat from the Hexagon Theatre, river-extractable heat capacity, and additional borehole heat capacity, were assessed and compared against the network heat demand.

This analysis enabled evaluation of the difference between demand and available low-carbon supply, forming the basis for thermal storage sizing. Results indicated that the period requiring the maximum beneficial storage capacity occurs during winter. A comparison of network heat demand and low-carbon heat supply over the winter period is presented in Figure 7. This graph highlights periods of excess heat from the low-carbon sources that can be stored within a thermal store.

Using a 30 K network temperature differential in line with the heat network design, and the density and specific heat capacity of water, the heat transfer equation was applied to determine the required storage volume. The results of this calculation indicate that 100 $m^3$ of thermal storage would be required.

The network design therefore incorporates a 100 $m^3$ thermal storage unit located within the car park.

Further optimisation at commercialisation will look at the opportunity to utilise variable electricity tariffs and the benefit of increasing the current TS selection.

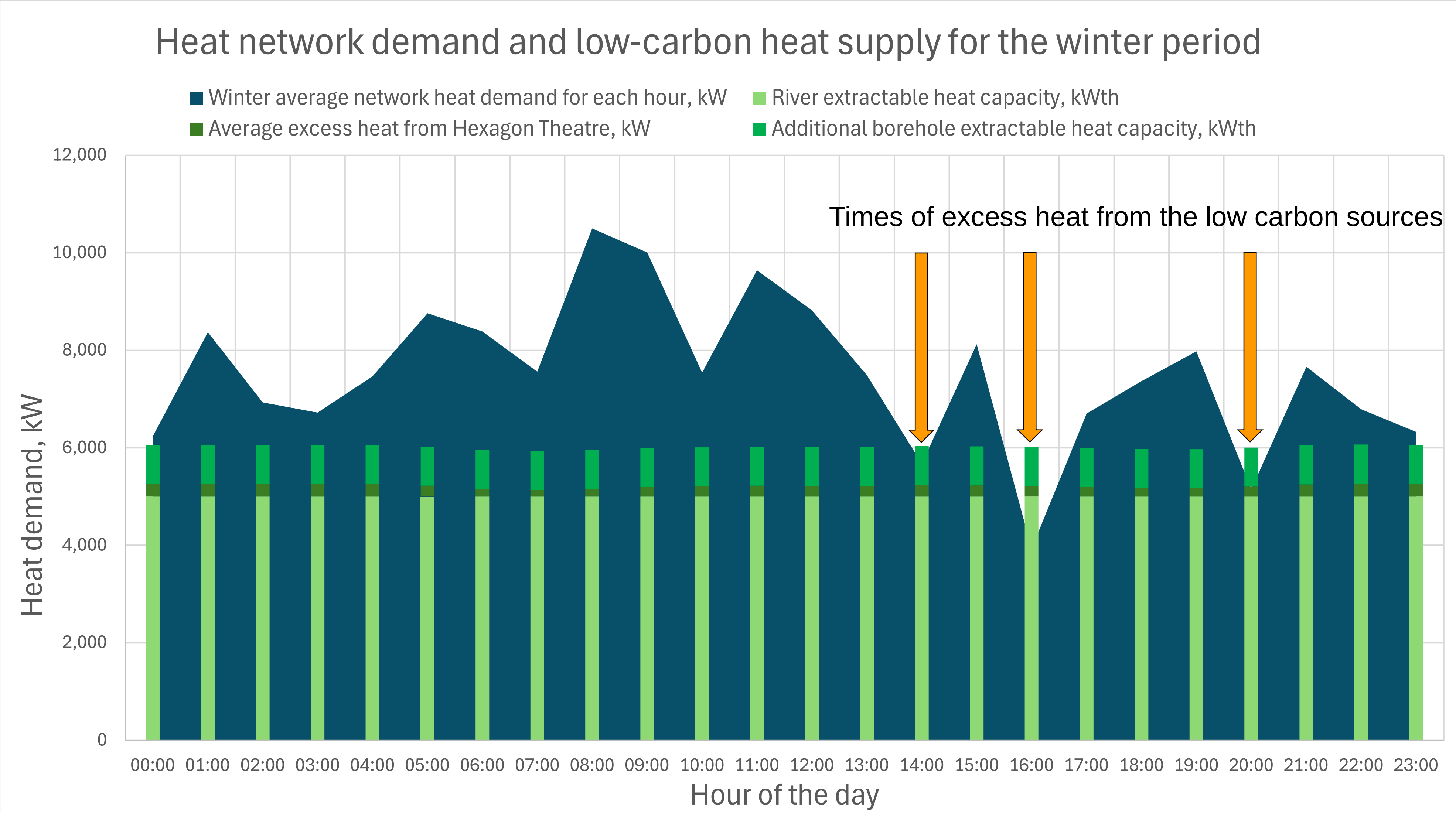


Figure 7: Thermal storage sizing analysis considering heat network demand and low-carbon heat supply for the winter period

# Pump/Expansion vessel sizing

To size the pumps and expansion vessels, the total volume of equipment, pipework, and thermal storage across the heat network was first determined. This volume was subsequently uplifted by 20% to account for pipework and equipment within the energy centre and substations, and to provide a margin for uncertainty.

As part of this assessment, the requirement for a buffer vessel was also considered. The calculated total network water volume, including the thermal store, was reviewed against the minimum buffer volume that would be required to meet heat pump operational constraints, such as minimum run time and turndown. The calculations demonstrate that the inherent water volume within the distribution pipework and thermal storage is significantly greater than the volume that would be required for buffering alone. As a result, the network itself provides sufficient thermal inertia, and no separate buffer vessel is required.

The resulting total system water volume formed the basis of the pressurisation and pump sizing exercises. In accordance with CIBSE AM14 and EN 12828, the expansion vessel sizing considered the thermal expansion of water between the cold fill condition and the maximum system operating temperature. Temperature-dependent water densities were used to calculate the volumetric expansion of the system, ensuring that expansion was represented accurately for the defined operating temperature range.

An additional allowance was included for system losses, such as minor leakage and maintenance activities, to ensure adequate reserve capacity was maintained. The expansion vessel was then sized to accommodate the combined expansion and reserve volumes while maintaining system pressures within defined limits. These limits were governed by the static head associated with the maximum network elevation, an allowance to prevent air ingress at the highest point of the system in line with CIBSE guidance, and the maximum allowable operating pressure dictated by the lowest-rated system component. A margin below the safety valve lift pressure was also maintained in accordance with EN 12828 to ensure stable pressurisation and avoid nuisance discharge.

Pump sizing was undertaken using the same system energy demand and temperature regime. The peak thermal capacities connected to the heat network were converted into design flow rates based on the specified flow and return temperatures and the specific heat capacity of water. An indicative pump head was assumed at this stage as a high-level allowance for network pressure losses. Detailed hydraulic modelling was not completed at DPD stage and should therefore be undertaken as a next step at the subsequent design stage.

The key outputs from this assessment are summarised in Table 8.

**Table 8: Key expansion vessel and pump outputs**

| Parameter | Value |
|---|---|
| Total system water volume | 252 $m^3$ |
| Required expansion vessel size | 16.1 $m^3$ |
| Design pump flow rate | 10 kg/s – Minster Quarter EC<br>40 kg/s – Car Park EC |
| Pump head | 4 bar – Minster Quarter and Car Park ECs |

# Heat Network Connections

To support the assessment of potential heat network connections, annual heat demand values and representative hourly demand profiles were established for each identified connection.

The heat network connections considered within the study include a combination of existing buildings, redevelopment sites, and residential or non-residential consumers. Depending on the information available for each connection, annual heat demand values were derived using metered consumption data, published datasets, stakeholder information, planning application information or benchmarking methodologies.

The resulting annual heat demand values, together with the key assumptions, benchmarks, and source data used to derive them, are presented in Table 9. Using the available profiles and annual heat demand values established in Table 9, representative hourly demand profiles were compiled or generated for each connection. These profiles were subsequently reviewed against known plant capacities, benchmark peak loads, and expected operational characteristics to derive representative peak heat demands suitable for district heat network modelling.

The resulting peak demands and the methodology used to source, generate, and validate the associated hourly profiles are presented in

Table 10.

**Notes**

- For all buildings where gas consumption has been converted to heat demand, a boiler efficiency of 85% has been assumed. For Kendrick School, which also uses oil, a boiler efficiency of 75% has been applied to oil consumption.
- Only values used to derive the annual heat demand or profile peak for each load are included in the tables below.
- Where half-hourly data was not provided, hourly heat demand profiles are generated using annual heat demand data.
- The profiling tool generates synthetic hourly profiles using built-in datasets and baseline assumptions. These include ambient weather data to capture seasonal variation, as well as typical splits between space heating and hot water demand. Representative daily profile shapes are applied based on building type, distinguishing between weekday and weekend operation. Together, these inputs produce an hourly demand profile that reflects typical usage patterns.
- Once generated, the profiles undergo a validation and sense-checking process. The modelled profile peak demand is compared against either the installed plant capacity or benchmark peak values. Where plant capacity is used, operational arrangements such as N+1 redundancy are considered to estimate the effective peak demand. Benchmark peak values are informed by sources such as BSRIA, AECOM project experience, and nPro.
- In parallel, the load factor is reviewed as an additional validation check, providing insight into how demand varies over the year and whether the profile is realistically shaped. Profiles that appear overly flat or excessively peaky can therefore be identified.
- Where discrepancies are identified, whether in terms of peak demand or load factor, the underlying assumptions are refined. This may include adjusting daily profile shapes, modifying the split between space heating and hot water, or refining operational assumptions. The profiles are then regenerated and reassessed.
- This iterative process helps ensure that the final hourly demand profiles are consistent with annual energy use while remaining aligned with typical peak demands and operational characteristics.
- Information shown in blue within the tables has been taken from the feasibility study, while information shown in green has been developed at DPD.

**Table 9: Annual energy demand and benchmarking key information**

| Reading Heat Network Loads | Annual Heat Demand | Annual Heat Demand Source | DEC Gas Data | Heat Benchmark | Gas Benchmark | Benchmark Source | Floor Area | Floor Area Source | Notes / explanation |
|---|---|---|---|---|---|---|---|---|---|
| Penta Hotel | 2,064 MWh | Metered data | | | | | 10,715 m$^2$ | EPC | The stakeholder confirmed that gas is used for the kitchen but is not separately metered. It has been assumed that 15% of total gas use is for catering, in line with CIBSE Guide F for hotel use, with the remainder attributed to heating and converted to annual heat demand using the assumed boiler efficiency. |
| MQ Redevelopment | 3,240 MWh | AECOM model | | 54 kWh/m$^2$/yr | | AECOM model | 60,000 m$^2$ | Estimated based on planning application information | The development is predominantly residential. An AECOM benchmark for comparable new builds has been applied, and the annual heat demand has been calculated based on the estimated floor area. |
| Magistrates Court | 572 MWh | DEC | 185.72 kWh/m$^2$/yr | | | | 3,625 m$^2$ | DEC | The DEC was used to obtain the floor area and annual gas use per m². This information was then used to calculate the building's total annual gas consumption, which was subsequently converted to annual heat demand using the assumed boiler efficiency. |
| Oracle Development | 1,594 MWh | Energy statement | | 33 kWh/m$^2$/yr | | Energy statement | 48,197 m$^2$ | Energy statement | Annual heat demand was calculated by multiplying the floor area by the heat benchmark, both of which were obtained from the energy statement submitted as part of the planning application. |
| Kendrick School | 1,577 MWh | RBC metered data FY 23-24 | | | | | 13,957 m$^2$ | EPCs | Both gas and oil are used for heating at this site. The annual heat demand was calculated using metered data and applying the assumed boiler efficiencies |
| University of Reading | 1,246 MWh | Metered data | | | | | 17,701 m$^2$ | Received information | The annual heat demand was calculated using metered data and applying the assumed boiler efficiency. |
| Royal Berkshire Hospital | 18,000 MWh | ERIC dataset 2023/24 | | | | | 119,830 m$^2$ | ERIC dataset 2023/24 | The annual heat demand was taken directly from the ERIC dataset. |
| Reading School | 2,027 MWh | Calculated from metered data and Reading School's Heat Decarbonisation Plan (HDP) | | | | | 24,226 m$^2$ | EPCs | Non-cooking gas consumption was taken from the HDP and subtracted from total gas use to determine gas used for heating. This was then adjusted using the assumed boiler efficiency. Electricity is also used for heating, with total electric boiler capacity obtained from the HDP. Given its relatively small capacity compared to gas, it was assumed to operate for the same annual hours. This was used to estimate annual electricity consumption for heating. The total annual heat demand was calculated as the sum of the gas and electricity contributions. |

| Reading Heat Network Loads | Annual Heat Demand | Annual Heat Demand Source | DEC Gas Data | Heat Benchmark | Gas Benchmark | Benchmark Source | Floor Area | Floor Area Source | Notes / explanation |
|---|---|---|---|---|---|---|---|---|---|
| Town Hall | 1,200 MWh | Metered data | | | | | 7,324 $m^2$ | EPC | The annual heat demand was calculated using metered data and applying the assumed boiler efficiency. |
| John Lewis Store | 5,716 MWh | Benchmarked data | | | 248 $kWh/m^2/yr$ | CIBSE Guide F | 27,125 $m^2$ | EPC | The CIBSE typical practice fossil fuel benchmark for department stores was multiplied by the EPC floor area to estimate total annual gas use. This was then converted to annual heat demand using the assumed boiler efficiency. |
| Visa Offices | 1,127 MWh | Benchmarked data | | | 178 $kWh/m^2/yr$ | CIBSE Guide F | 7,450 $m^2$ | EPC | The CIBSE typical practice fossil fuel benchmark for a standard air-conditioned office was multiplied by the EPC floor area to estimate total annual gas use. This was then converted to annual heat demand using the assumed boiler efficiency. |
| Homes for Students Kendrick Hall | 2,670 MWh | Benchmarked data | | | 199 $kWh/m^2/yr$ | CIBSE Benchmarking Tool (value derived from DECs) | 15,779 $m^2$ | EPC | The CIBSE typical practice fossil fuel benchmark for a residential higher education building was multiplied by the EPC floor area to estimate total annual gas use. This was then converted to annual heat demand using the assumed boiler efficiency. |
| Aparto Student Accommodation | 1,826 MWh | Benchmarked data | | | 199 $kWh/m^2/yr$ | CIBSE Benchmarking Tool (value derived from DECs) | 10,798 $m^2$ | EPC | The CIBSE typical practice fossil fuel benchmark for a residential higher education building was multiplied by the EPC floor area to estimate total annual gas use. This was then converted to annual heat demand using the assumed boiler efficiency. |

**Table 10: Profiling and peak heat demand key information**

| Reading Heat Network Loads | Profiling and Peak Heat Demand | | |
|---|---|---|---|
| | Profile Peak | Source | Notes / Explanation |
| Penta Hotel | 1.8 MW | Feasibility study – AECOM's non-resi profiling tool | Profile taken from the MQ feasibility study, developed using the metered annual heat demand and AECOM's non-residential profiling tool for an existing hotel. |
| MQ Redevelopment | 2.2 MW (Resi-only)<br><br>0.2 MW (Non-resi only) | AECOM's resi and non-resi profiling tools | At DPD, the residential and non-residential elements were separated from the overall heat demand in the feasibility study to generate two profiles for this connection. Annual heat demands were derived from floor areas and heat benchmarks taken from the planning application, with residential and non-residential components of 2,993 MWh and 247 MWh respectively.<br><br>AECOM's residential profiling tool was used to generate the residential profile and scaled to match the calculated annual energy, while the non-residential profile was produced using AECOM's non-residential profiling tool, assuming a leisure profile, and scaled accordingly. |
| Magistrates Court | 0.4 MW | Feasibility study – AECOM's non-resi profiling tool | Profile taken from the MQ feasibility study, developed using the calculated annual heat demand and AECOM's non-residential profiling tool for an existing public building. |
| Oracle Development | 1.4 MW (Resi-only)<br><br>0.2 MW (Non-resi only) | AECOM's resi and non-resi profiling tools | At DPD, the residential and non-residential elements were separated from the overall heat demand in the feasibility study to generate two profiles for this connection. Annual heat demands were derived from floor areas and heat benchmarks taken from the planning application, with residential and non-residential components of 1,392 MWh and 203 MWh respectively.<br><br>AECOM's residential profiling tool was used to generate the residential profile and scaled to match the calculated annual energy, while the non-residential profile was produced using AECOM's non-residential profiling tool, assuming a leisure profile, and scaled accordingly. |
| Kendrick School | 1.4 MW | AECOM's non-resi profiling tool | No boiler capacity or location information was received alongside the consumption data. The profile was developed using the metered annual heat demand and AECOM's non-residential profiling tool for an existing educational establishment.<br><br>The peak generated by the tool was compared against the BSRIA educational benchmark (87 $W/m^2$) to confirm it was within a reasonable range. The AECOM calculated peak was 98 $W/m^2$, corresponding to a 12% difference relative to the benchmark, which was deemed acceptable. |
| University of Reading | 2.0 MW | Obtained gas boiler information and AECOM's resi and non-resi profiling tools | Peak heat demand was derived from the installed gas boiler capacities. Where multiple boilers were present in any of the university buildings, an N+1 arrangement was assumed, and the total output excluding standby capacity was taken as the building peak demand.<br><br>The profile was generated using AECOM's synthetic profile generator for an existing educational establishment, with total demand and peak demand adjusted to align with the calculated values. |
| Royal Berkshire Hospital | 11.0 MW | AECOM's non-resi profiling tool | No boiler capacity or location information was received alongside the consumption data. The profile was developed using the annual heat demand from ERIC data and AECOM's non-residential profiling tool for an existing healthcare building.<br><br>The peak generated by the tool was compared against the nPro Energy benchmark (92 $W/m^2$).<br>The AECOM calculated peak was also 92 $W/m^2$, resulting in a 0% difference, confirming alignment with the benchmark. |

| Reading Heat Network Loads | Profiling and Peak Heat Demand | | |
|---|---|---|---|
| | **Profile Peak** | **Source** | **Notes / Explanation** |
| Reading School | 1.5 MW | Obtained gas and electric boiler information and AECOM's resi and non-resi profiling tools | Peak heat demand was derived from the installed gas and electric boiler capacities. Where multiple gas or multiple electric boilers were present in any of the school buildings, an N+1 arrangement was assumed, and the total output excluding standby capacity was taken as the building peak demand.<br><br>The profile was generated using AECOM's synthetic profile generator for an existing educational establishment, with total demand and peak demand adjusted to align with the calculated values. |
| Town Hall | 0.5 MW | Received half-hourly data | Profile developed using received half-hourly data. Approximately two weeks of half-hourly readings were missing. This period was reconstructed using a representative profile derived from the available data and the corresponding missing portion of the total annual heat demand. |
| John Lewis Store | 2.8 MW | AECOM's non-resi profiling tool | Profile developed using the benchmarked annual heat demand and AECOM's non-residential profiling tool for an existing retail building.<br><br>The peak generated by the tool was compared against the BSRIA retail benchmark (100 W/m²) to confirm it was within a reasonable range. The AECOM calculated peak was 102 W/m², corresponding to a 2% difference relative to the benchmark, which was deemed acceptable. |
| Visa Offices | 0.6 MW | AECOM's non-resi profiling tool | Profile developed using the benchmarked annual heat demand and AECOM's non-residential profiling tool for an existing public building.<br><br>The peak generated by the tool was compared against the BSRIA offices benchmark (70 W/m²) to confirm it was within a reasonable range. The AECOM calculated peak was 80 W/m², corresponding to a 12% difference relative to the benchmark, which was deemed acceptable. |
| Homes for Students Kendrick Hall | 1.9 MW | AECOM's resi profiling tool | Profile generated using AECOM residential profiling tool, a load factor was then calculated to be 16% which was deemed acceptable. |
| Aparto Student Accommodation | 1.4 MW | AECOM's non-resi profiling tool | Profile generated using AECOM residential profiling tool, a load factor was then calculated to be 15% which was deemed acceptable. |