STROUD DISTRICT COUNCIL
Council Offices • Ebley Mill • Ebley Wharf • Stroud • GL5 4UB
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1 July 2020

# STRATEGY AND RESOURCES COMMITTEE

A remote meeting of the Strategy and Resources Committee will be held on **THURSDAY 9 JULY 2020** at **7.00 pm**.

Kathy O'Leary
Chief Executive

*This is a remote meeting in accordance with the Local Authorities and Police and Crime Panels (Coronavirus) (Flexibility of Local Authority and Police and Crime Panel Meetings) (England and Wales) Regulations 2020.*

**Venue**
*This meeting will be conducted using Zoom and a separate invitation with the link to access the meeting will be sent to Members, relevant officers and members of the public who have submitted a question.*

**Public Access**
*Members of the public, who have not submitted a question, are invited to access the meeting streamed live via Stroud District Council's YouTube channel.*

**Recording of Proceedings**
*A recording of the meeting will be published onto the Council's website (www.stroud.gov.uk). The whole of the meeting will be recorded except where there are confidential or exempt items, which may need to be considered in the absence of press and public.*

## AGENDA

**1** **APOLOGIES**
To receive apologies for absence.

**2** **DECLARATIONS OF INTEREST**
To receive declarations of interest.

**3** **MINUTES**
To approve the Minutes of the meeting held on 18 June 2020.

**4 PUBLIC QUESTION TIME**

The Chair of the Committee will answer questions from members of the public, submitted in accordance with the Council's procedures.

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|---|
| **DEADLINE FOR RECEIPT OF QUESTIONS**<br>**Noon on Monday, 6 July 2020**<br><br>Questions must be submitted to the Chief Executive, Democratic Services, Ebley Mill, Ebley Wharf, Stroud and can be sent by email to democratic.services@stroud.gov.uk |

**5 WATER-SOURCE HEAT PUMPS – EBLEY MILL AND BRIMSCOMBE PORT MILL**

To present the business case for the installation of water-source heat pumps at Ebley Mill, Cainscross and Brimscombe Port Mill, Thrupp.

**6 MEMBER/OFFICER REPORTS**

***a) Performance Monitoring *****
b) Investment and Development Panel
c) Leadership Gloucestershire Update
***d) Gloucestershire Economic Growth Joint Committee (GEGJC) on 3 June 2020*****
e) Gloucestershire Economic Growth Scrutiny Committee (GEGSC)
f) Brimscombe Port Project Board
***g) Corporate Delivery Plan Progress Update Quarter 4 and Appendix 1 *****

***(** reports circulated to Members on 24 June 2020)***

**7 WORK PROGRAMME**

To consider the work programme.

**8 MEMBERS' QUESTIONS**

See Agenda Item 4 for deadline for submission.

**Members of Strategy and Resources Committee 2020/21**

**Councillor Doina Cornell (Chair)**
**Councillor Martin Whiteside (Vice-Chair)**
Councillor Nigel Cooper
Councillor Stephen Davies
Councillor Nick Hurst
Councillor Keith Pearson
Councillor Simon Pickering
Councillor Steve Robinson
Councillor Mattie Ross
Councillor Tom Skinner
Councillor Chas Townley
Councillor Ken Tucker
Councillor Debbie Young

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# STRATEGY AND RESOURCES COMMITTEE

3

**18 June 2020**

**7.00 pm – 9.16 pm**

**Remote Meeting**

**Minutes**

**Membership**

| | | | |
|---|---|---|---|
| **Councillor Doina Cornell (Chair)** | P | Councillor Steve Robinson | P |
| **Councillor Martin Whiteside (Vice-Chair)** | P | Councillor Mattie Ross | P |
| Councillor Nigel Cooper | P | Councillor Tom Skinner | P |
| Councillor Stephen Davies | P | Councillor Chas Townley | P |
| Councillor Nick Hurst | P | Councillor Ken Tucker | P |
| Councillor Keith Pearson | P | Councillor Debbie Young | A |
| Councillor Simon Pickering | P | | |

P = Present A = Absent

**Officers in Attendance**

| | |
|---|---|
| Chief Executive | Strategic Director of Transformation & Change |
| Interim Head of Legal Services & Monitoring Officer | Strategic Director of Communities |
| Strategic Director of Resources | Revenue and Benefits Manager |
| Strategic Director of Place | Corporate Policy and Governance Manager |
| | Democratic Services and Elections Officer |

**Other Member(s) in Attendance**

Councillors Hall, Lydon and Studdert-Kennedy.

## SRC.008 APOLOGIES

An apology for absence was received from Councillor Young.

## SRC.009 DECLARATIONS OF INTEREST

There were none.

## SRC.010 MINUTES

**RESOLVED** **That the Minutes of the meeting held on 21 May 2020 are approved as a correct record.**

The Chair confirmed that there had been quite a few questions from members of the public on the black lives matter movement.

Miriam Lewis had been invited by the Leader to inform members of her own and her family's experiences of racism as a resident within the district. She also suggested we could work towards a better, more inclusive tomorrow through education, representation and resources to address inclusion.

On 8 June 2020 a statement had been signed by the Council's Group Leaders condemning racism and reaffirming the Council's commitment to promote equality and tackle discrimination.

The Leader read out a statement outlining her own personal experiences of racism and condemning all forms of racism against BAME (Black, Asian and Minority Ethnic) people within our district. She stated that we need to do all we can as a Council to ensure we are an inclusive and anti-racist organisation with zero tolerance for racism and discrimination.

## SRC.011 PUBLIC QUESTION TIME

Questions had been submitted by several members of the pubic and they were answered by the Leader, Councillor Cornell and the Council's Chief Executive. (Refer to the Council's recording of the meeting).

## SRC.012 COUNCIL TAX HARDSHIP SCHEME – COVID-19

The Revenue and Benefits Manager introduced the above report for immediate implementation. A review would be undertaken later in this civic year and a report submitted to Committee.

The following responses were given to Members' questions:-

- Consideration would be given to Discretionary Housing Benefit where applicable at application.
- The application form for hardship schemes could be adapted for both schemes once things settled down.
- The Government Grant for the Council Tax Hardship Scheme was limited to this scheme only. A monitoring mechanism was in place to ensure there would be no overspend.
- The scheme would run for the rest of this financial year, 2020/21.

Councillor Pickering proposed the report, which was seconded by Councillor Townley.

Councillor Pickering welcomed this report and was pleased the scheme had been introduced and hoped all Members would support it.

The Leader echoed Councillor Pickering's words, stating that the Council could now provide additional financial help as soon as possible to the new applicants. This would also enable the Council to identify it's most vulnerable residents.

Councillor Townley was pleased that the Council were able to give this extent of support and also that we were looking into integrating the application form for claiming both of the discretionary grants.

The Leader thanked the Revenue and Benefits Manager, together with his staff for all of their hard work with discretionary business grants and the hardship scheme. It was important that help was given to those who needed it.

On being put to the vote, the Motion was unanimously carried.

**RESOLVED**

**a. To approve the changes to the Section 13a Hardship Policy to allow for immediate implementation of the Government Covid-19 funding.**

**b. That a report is take to the next available meeting of Council to formally adopt the amended Section 13a Hardship Policy.**

## SRC.013 COVID-19 RECOVERY STRATEGY

The Strategic Director of Place outlined the above report, highlighting the four work streams and the key points in Section 2. The Council would be working in close collaboration with Parish and Town Councils, together with other partner organisations regionally, nationally and the business community going forward. We would need to remain flexible. He advised that there was still a lot we do not know about what the impact on the community will be when the furlough scheme ends.

This was the beginning of a journey and there would be regular updates and opportunities for Members and Committees to steer this work.

In response to questions it was stated that the action plan was not specific but environmental and equality implications would be reviewed as the action plans were developed.

Councillor Townley proposed the report, which was seconded by Councillor Pickering.

Councillor Townley stated that this was a great opportunity to shape our recovery going forward, particularly for housing. A workshop had been scheduled with Town and Parish Councils to help recovery of the high streets and also to address issues across the district. We have to be prepared to deal with risks that are likely to happen. The approach was really good with a lot of Member involvement across all parties to develop this report.

Councillor Davies confirmed that a lot of work and discussions had already taken place and we would need a huge amount of partnership working and tap into any grants that may be available. We are spending public money and needed to spend it efficiently.

Councillor Hurst stated that the money was from Central Government and it was likely that this may affect our Rates Support Grant in years to come.

Councillor Whiteside stated that we needed to take action for a recovery that benefitted the groups most affected by the crisis and also was environmentally beneficial. In time residents would be encouraged to do more walking, cycling and use public transport; reducing air pollution and the carbon footprint. We will be working with Town and Parish Councils, GFirst LEP, businesses and other partners.

Councillor Pickering stated that it was important that we build in resilience and make sure the economy and social systems would be able to deal with future needs. It was important that we deal with how we adapt locally to build a new normal and build a future.

Councillor Ross thanked the Strategic Director of Place and all participants for their tremendous amount of work. Councillor Ross also acknowledged the valuable community work that had been going on and stated people knew their own patches and had worked in partnership. We had begun to look at our leisure and culture and must also now look at the health and wellbeing of people coming out of this pandemic.

The Leader had worked closely with the Strategic Director of Place and this was a very diverse Committee whose Members had all made valuable points. Confirming that she would be leading on the economy, the next report would be on the financial position of the Council. Working with external partners would be crucial e.g. GFirst LEP and receiving funds from Central Government. The Council would be leading on this work. The District Councils Network meet weekly and share a lot of work in common and identified statutory obligations e.g. housing, licensing and planning; using these in a good way can help the economy. Stepping up on our housing programme would help the local economy. Community wealth building is needed to develop this work and make sure we do everything we can and keep the monies within our communities. We can learn from others.

Councillor Townley summed up, the recent flooding in Nailsworth was not an isolated case, physical infrastructure cannot deal with large amounts of water on the road. He hoped all members would support the report tonight.

On being put to the vote, the Motion was unanimously carried.

**RESOLVED**

**a. To endorse the approach as outlined in the Draft Recovery and Renewal Strategy document, attached as Appendix 1.**

**b. To endorse the draft governance arrangements attached as Appendix 2.**

## SRC.14 FINANCIAL IMPACT OF COVID-19 ON STROUD DISTRICT COUNCIL

The Strategic Director of Resources outlined the report and confirmed that the pandemic was having a significant impact on the Council's financial resources. We are required under the rules to report once a month to Central Government the impact of the pandemic; the report was based on figures from 15 May 2020. The next report to Central Government was finalised this afternoon and the overall picture was nearly identical.

Lock down began in late March 2020 and therefore had a minimal impact on the 2019/20 budgets. The outturn report mentioned in paragraph 2.1 of the report will be available mid-late July 2020. The worst case financial assumptions had been listed within the report and were not assumptions on Council Policy. We are keen to work in partnership with Town and Parish Councils to help with reopen high streets and this will include car park charges.

On the HRA the major concern is about housing rents and the CPI assumption on the 30 year plan and inflation. The capital programme has no major changes because it is too early to say at the moment. Section 6 of the report details the mitigation on Medium Term Financial Plan and the Council is in a strong reserve position. The sum of £3.8m is in an equalisation reserve which gives us time to make efficiencies and receive funding. This can be used to meet the gap. We have already received funding from Government of £1.2m towards the cost of the crisis. In July a briefing on the financial position of the HRA will be taking place for all Members.

The following responses were given to Members' questions:-

- It is assumed that most of the income expected would be lost, e.g. from the Pulse and the Museum.
- Some planning applications would have been delayed, we will have to look at this later in the year.

- The estimated £200k extra costs for repairs and maintenance is because during the lockdown only urgent repairs were carried out. It was estimated that there would be additional staff required to catch up from the backlog and the additional cost of PPE.
- Rent arrears are higher than last year, evidence showed that it is harder for people to pay. This is an estimated figure.
- Historical data from the 2008 recession could be useful to compare with the impact of Covid-19. The Director would look to see if there is any data available.
- One of the biggest decisions is around the car parking charges which have currently been suspended as part of the economic recovery. The income would be welcome but the shops are only beginning to re-open and car parking charges would come after that.
- There is a real need for support from Government to local authorities in the longer term. There may be a Government announcement in late June/July. Members will be updated and where decisions have to be made reports will be brought back to Committee.

The report was proposed by Councillor Townley and seconded by Councillor Cornell.

During debate Councillor Pickering said this was a helpful report but we were in moving times and it was difficult to make predictions. Government needs to set out how local authorities are to deal with the recovery in the long term. We should use the Equalisation Reserves for the predicted losses but we need to use them carefully and make best use of them.

Councillor Townley congratulated Officers for their report. The Leader confirmed that there were a lot of uncertainties and we should take all of this information on board.

On being put to the vote, the Motion was unanimously carried.

**RESOLVED**

**a. The estimated impact of Covid-19 on the financial position of the Council be noted.**
**b. It agrees with the Section 151 Officers opinion that the Council's Equalisation Reserve should be used to meet the cost of the pandemic.**

**<u>SRC.015</u> <u>WORK PROGRAMME</u>**

A work programme planning meeting had been arranged for 23 June 2020 at 10.00 am when future items would be discussed. At the next Committee meeting a report on Water Source Heat Pumps at Ebley Mill and Brimscombe Port would be on the agenda and invitations had been sent out for a Members' briefing session on 24 June 2020 at 6pm.

The following items were suggested for inclusion on the work programme:-
- Brimscombe Port
- Financial Impact of Covid-19 on Stroud District Council – this would be a regular item
- Local Plan – this may be Environment Committee
- Funding of the Council's Play Areas

**RESOLVED** **To note the above updates to the Work Programme.**

## SRC.016 MEMBERS' QUESTIONS

There were none because Councillor Lydon withdrew his question.

The meeting closed at 9.16 pm.

Chair

**STROUD DISTRICT COUNCIL**

**STRATEGY AND RESOURCES COMMITTEE**

**9 JULY 2020**

**AGENDA ITEM NO**

**5**

| | |
|---|---|
| **Report Title** | **WATER-SOURCE HEAT PUMPS – EBLEY MILL AND BRIMSCOMBE PORT MILL** |
| **Purpose of Report** | To present the business case for the installation of water-source heat pumps at Ebley Mill, Cainscross and Brimscombe Port Mill, Thrupp |
| **Decision(s)** | **That Strategy and Resources Committee RECOMMENDS to Council to allocate capital funding in 2020/2021 to invest in water source heat pumps as follows;**<br><br>**a. the sum of £1.05m at Ebley Mill and**<br><br>**b. the sum of £382k at Brimscombe Port Mill and**<br><br>**c. that, in consultation with the Leader, the Head of Property Services is given delegated authority to proceed with the procurement and installation of the heat pumps subject to the receipt of the necessary consents from the Environment Agency and a successful application to the Non-Domestic Renewable Heat Incentive Scheme.** |
| **Consultation and Feedback** | Head of Community Services<br>Carbon Neutral Officer – see Environmental Implications |
| **Report Author** | Brian McGough, Buildings Programmes Manager<br>Tel: 01453 754411 Email: brian.mcgough@stroud.gov.uk<br><br>Alison Fisk, Head of Property Services<br>Tel: 01453 754430 Email: alison.fisk@stroud.gov.uk |
| **Options** | <u>Ebley Mill</u> – if the option of a water-source heat pump is not supported, the main gas boilers are likely to need replacing within the next few years. This may be replacement with modern gas boilers or alternatively a biomass system.<br><br><u>Brimscombe Port Mill</u> – if the option of a water-source heat pump is not supported, the current gas boilers will be relocated into the Mill to continue providing heating and to facilitate the demolition of the Port House as part of the redevelopment proposals for the site. A biomass system could also be considered. |

<table>
<tr><td rowspan="1">Options</td><td colspan="4"><u>Both sites</u><br>There are a number of factors which would affect the choice of a replacement system including space for a silo to store the biomass wood pellets if biomass is used.<br><br>The use of modern gas fired boilers and controls represents a significant reduction in capital cost compared with water source heat pumps or biomass systems but are expected to be phased out for non-domestic properties.<br><br>Modern gas boilers are about 97% efficient but biomass is regarded as more sustainable, although there are concerns over the reliability of fuel supply chains.</td></tr>
<tr><td>Background Papers</td><td colspan="4">None</td></tr>
<tr><td>Appendices</td><td colspan="4">Appendix A – Feasibility report, Brimscombe Port Mill (Issue 4)<br>Appendix B – Feasibility report, Ebley Mill (Issue 3)</td></tr>
<tr><td rowspan="2">Implications<br>(further details at the end of the report)</td><td>Financial</td><td>Legal</td><td>Equality</td><td>Environmental</td></tr>
<tr><td>Yes</td><td>Yes</td><td>No</td><td>Yes</td></tr>
</table>

## 1. INTRODUCTION

1.1 Ebley Mill and Brimscombe Port Mill are currently heated by mains gas, resulting in a large carbon footprint for both properties. Bearing in mind the Council's commitment to Carbon Neutral 2030, a more renewable heating system would ideally replace the existing gas system within the next few years. As both properties are adjacent to water, the feasibility of using water-source heat pumps was considered as a possible replacement heating system.

1.2 The Council commissioned Renewables First (an engineering consultancy specialising in hydropower and water-source heat pumps), to undertake initial feasibility studies for the installation of water-source heat pumps at both properties and to carry out further tests to check their projections. Their feasibility reports are appended to this report.

1.3 The feasibility studies were then reviewed by Withycombe Design (WDS), consulting mechanical engineers. They confirmed that a series of comments and technical queries they raised have had satisfactory answers and they also met with Renewables First to discuss the scheme in more detail.

1.4 The (Non-Domestic) RHI is a UK Government environmental scheme which aims to encourage uptake of renewable heat technologies amongst householders, communities and businesses through financial incentives, and contribute towards the 2020 ambition of 12% of heating coming from renewable sources. Eligible installations from businesses, the public-sector and non-profit making organisations receive quarterly payments based on the amount of heat generated. Both projects are potentially eligible for the Renewable Heat Incentive (RHI), which provides a guaranteed quarterly payment (per kWh used) for approximately 20 years. This is a significant source of revenue; however, the scheme is due to close shortly so the projects would need to progress quickly in order to be eligible for payments. The scheme is administered by Ofgem.

1.5 As an alternative to either continued usage of gas or installation of a water-source heat pump system, biomass could also be considered. This would have a lower installation cost than the heat pump system, however it will require regular fuel deliveries and careful arrangement of a sustainable fuel supply. In addition, the RHI for biomass (3.15 p/kWh) is less than half of the expected rate for heat pumps (6.98 p/kWh). The option of using biomass is considered an inferior option to the use of heat pump technology and there are supply chain concerns, which may mean that a sustainable fuel supply is hard to guarantee.

## 2. OVERVIEW – EBLEY MILL

2.1 Ebley Mill is a Grade II* Listed Building, heated primarily by three large gas boilers, which are due for replacement within the next 10 years. In addition, there are two smaller gas boilers in a separate plant room, which were installed more recently. Secondary glazing has been installed throughout the building.

2.2 The report by Renewables First indicates that the river and canal are both suitable for a water-source heat pump system, which could easily provide sufficient heat for Ebley Mill.

2.3 The report shows that it is likely to be cost-effective to replace radiators throughout, to increase their heat output. This additional cost will be more than compensated for by the improvement in performance, as it will allow a lower flow temperature to be used.

2.4 Withycombe advised that the total costs of the works would be greater than Renewables First have indicated, as their costs do not include the cost of a new plant room, all builders' work (to enable the engineering installations to be installed) and all necessary consents and fees. The additional costs for these elements are shown in the tables below.

2.5 During the detailed design, it may be shown that a lower heat output would be sufficient. This could significantly reduce the project costs and improve the financial return.

2.6 The proposal could also be improved technically by the installation of further insulation to the building and changes to the glazing and natural ventilation. The additional cost of these measures may be balanced out by a reduction in the heat pump system costs. However, the tight timescales associated with the heat pump project may preclude this, as precise details of the heat demand of the building need to be submitted to Ofgem during September 2020 to achieve the anticipated RHI rate.

## 3 OVERVIEW – BRIMSCOMBE PORT MILL

3.1 The Mill at Brimscombe Port is a Grade II Listed Building, similar in construction but on a smaller scale to Ebley Mill. The boilers serving the mill are located in a separate building known as The Port House, which is due to be demolished as part of the infrastructure works to the Port, facilitating the reinstatement of the canal and basin and redevelopment of the Port (subject to planning and Listed Building consents, currently awaited). As part of de-risking the site, the boilers were due to be relocated into The Mill this summer. They are relatively new having being installed in 2013 by Stroud Valleys Canal Company, prior to the council managing the site.

3.2 The Mill and Port are now owned by Stroud District Council, having transferred on 1st April, but Homes England retain charges on the property, which will be released once the Port has been developed.

3.3 The report by Renewables First indicates that the river is suitable for a water-source heat pump system, which could easily provide enough heat for The Mill.

3.4 As with Ebley Mill, Withycombe advised that the total costs of the works they have indicated would be greater than the costs stated by Renewables First, as their costs do not include the cost of a new plant room, all builders' work (to enable the engineering installations to be installed) and all necessary consents and fees. The additional costs for these elements are shown in the tables below.

3.5 The proposal could also be improved technically by the installation of further insulation to the building and changes to the glazing and natural ventilation. The additional cost of these measures may be balanced out by a reduction in the heat pump system costs. However, the tight timescales associated with the heat pump project may preclude this, as precise details of the heat demand of the building need to be submitted to Ofgem during September 2020 to achieve the anticipated RHI rate.

## 4 FINANCES

4.1 The following tables show the capital cost, revenue and net present value of the water-source heat pump projects. Also shown are counterfactual scenarios for continued use of gas, with replacement of gas boilers as they reach the end of the useful life and for biomass.

4.2 The capital costs are based on estimates by Renewables First and Withycombe following completion of the feasibility studies. The accuracy of the cost estimates will be improved at two key stages: 1) Competitive tender bids for design & build; 2) Completion of detailed heat demand modelling, to confirm the heat pump capacity required.

Table 1: Comparison of Net Present Values for Heating Systems at Ebley Mill

| Heating system | Water-Source Heat Pump | | Gas | Biomass |
|---|---|---|---|---|
| | Sept RHI sub-mission | Impact of 3 month delay to Programme | | Sept RHI Submission |
| Date of Ofgem Stage 1 submis-sion | Sept 2020 | Dec 2020 | n/a | Jul-Sept 2020 |
| Total cost in Year 0 | £1,045,627 | £1,045,627 | 0 | £515,000 |
| Total cost in Year 1 | 0 | 0 | 0 | £0 |
| Total cost in Year 5 | 0 | 0 | £60,000 | £0 |
| Total cost in Year 16 | 0 | 0 | 0 | £0 |
| Total cost in Year 20 | 0 | 0 | £80,000 | £0 |
| RHI annual revenue | £41,934 | £37,741 | n/a | £18,924 |
| Existing revenue costs | | | | £23,210 |
| Reduction in annual running costs | £35 | £35 | | -£10,821 |
| Total effective annual revenue during RHI period | £41,969 | £37,776 | | £8,104 |
| Net present value over 25 years (0% discount rate) | -£5,321 | -£109,247 | -£140,000 | Not provided |
| Net present value over 25 years (3.5% discount rate) | -£311,984 | -381,747 | -£132,652 | -£410,031 |

Table 2: Comparison of Net Present Values for Heating Systems at Brimscombe Port Mill

| Heating system | Water-source heat pump | | Gas | Biomass |
|---|---|---|---|---|
| | Sept RHI submission | Impact of 3 month delay to Programme | | Sept RHI Submission |
| Date of Ofgem Stage 1 submission | Sept 2020 | Dec 2020 | n/a | Jul-Sept 2020 |
| Total cost in Year 0 | £382,998 | £382,998 | £0 | £265,000 |
| Total cost in Year 1 | £0 | £0 | £50,000 | £0 |
| Total cost in Year 5 | £0 | £0 | £0 | £0 |
| Total cost in Year 16 | £0 | £0 | £20,000 | £0 |
| Total cost in Year 20 | £0 | £0 | £0 | £0 |
| RHI annual revenue | £17,350 | £15,615 | n/a | £7,830 |
| Existing Running costs | | | | £11,780 |
| Reduction in annual running costs | £2,700 | £2,700 | | -£3,164 |
| Total effective annual revenue during RHI period | £20,050 | £18,315 | | £4,666 |
| Net present value over 25 years (0% discount rate) | £127,000 | £84,408 | -£70,000 | Not provided |
| Net present value over 25 years (3.5% discount rate) | -£30,570 | -£59,434 | -£66,979 | -£198,905 |

*Source: Renewables First*

## 5 PROGRAMME

5.1 The target programme for both sites is:

- Jun 2020 Consent applications (EA)
- Jun 2020 Competitive tender advertised for design & installation
- Jul 2020 Appointment of main contractor
- Aug-Sep 2020 Detailed design
- Sep 2020 Consents granted
- Sep 2020 Stage 1 Ofgem applications
- ***31 Sep 2020 Deadline for Stage 1 Ofgem application to avoid RHI degression***
- Oct 2020 Stage 2 Ofgem applications*
- Dec 2020 Place order for main components
- Mar-May 2021 Installation & commissioning
- Mar-May 2021 Stage 3 Ofgem applications

**Arrangements for project financing need to be finalised by this point*.

5.2 The Stage 1 Ofgem application is an important step as this will secure the RHI tariff rate. This application can only be made once the necessary consents have been obtained and sufficient design work has been completed to finalise the basic parameters of the system such as heat output and heat demand profile.

5.3 If installation and commissioning takes place after 31st March 2021, the RHI period will be slightly shorter than 20 years, as no payments will be made after 31st March 2041.

This means that the system would ideally be commissioned by 31st March 2021, however the impact of slight delays beyond this is relatively minor.

## 6 RISKS

6.1 Inadequate heat supply. The heat pump system may not provide enough heat, or may not heat the building up quickly enough. However, Renewables First assure us that, as long as the detailed design is done to a good standard, this is a very low risk. The heat pump system and radiators will be specified to ensure that the heat supply and warm-up times are suitable. Water-source heat pumps are not a new technology and have been used effectively elsewhere. It is possible to retain the gas boilers as a back-up system, but this would add cost and complication, and could diminish the carbon reductions.

6.2 Disruption to occupiers during installation. The installation is likely to take place during the 2020/21 heating season, so will result in some disruption. This is particularly the case at Ebley Mill, where the gas boilers will probably need to be removed before the heat pumps are installed.

6.3 Impacts on occupiers during operation. Occupiers may also be affected by a change in the behaviour of the heating system. For example, the heat pump will be designed to operate more consistently, so warm-up times may be increased slightly (a higher output heat pump system would avoid this, but may not be cost-effective). Likewise, the internal temperature may slightly lower than the existing internal temperature (again, a higher output heat pump would allow higher temperatures to be achieved, but may not be cost-effective).

6.4 Change of Use of Buildings – if there were to be a change of use for either building to residential within the payback period the project would still fall under the same Non-Domestic RHI scheme and would receive the same tariff rate. However, the project would become a 'shared ground loop' installation, for which slightly different rules apply. We are advised that there doesn't appear anything in the legislation that prohibits such a change but this would need to be confirmed before the Council was committed to going ahead with either installation to determine whether there would be any impact on the payback period.

(NB If water source heat pumps are not installed now; a non-gas system would need to be installed when the gas boilers need replacing as gas installations in domestic properties are due to stop in 2025. The current RHI scheme will not be available beyond 2021 see 6.6 below)

6.5 Early disposal of building assets. An early disposal of the mill buildings within the payback period will mean that the Council will not have received the income to payback capital. It may be that the water source heat pump would increase the market value or marketability of the buildings.

6.6 Not meeting RHI deadlines. The Renewable Heat Incentive deadlines may not be met and payback forecast wouldn't be achieved. The current official deadline for installation is 31st March 2021, however the Government has indicated that they intend to allow installation & commissioning after this date (until 31st March 2022) providing that 'stage 2' (financial close) information has been submitted to Ofgem by 31st March 2021. RHI payments would end on 31st March 2041, so payments may be made for slightly less than 20 years.

6.7 The government has stated that a new programme of grant support called the Clean Heat Grant will replace the RHI from April 2022, however this is expected to consist of grants of up to £4,000 and only for installations of up to 45 kW, so would not be suitable for these projects.

6.8 Consenting delays or difficulties. Consent is required from the Environment Agency together with Listed Building Consents although initial discussions have been held with positive responses. The longest determination period will be for the abstraction licence at Ebley Mill, which is expected to take at least three months.

6.9 Impacts of COVID-19. The effects of COVID-19 could potentially affect the programme, which is highly sensitive to delays given the requirement to meet various RHI deadlines. COVID-19 will have resulted in delays for many projects and a backlog of installations for contractors to complete once restrictions are fully lifted. This may also reduce the number of good tender responses received.

6.10 Reduction of RHI tariff rate. The RHI is also subject to quarterly degressions (rate reductions), due to which the projects would need to be consented and have secured funding by 31st September 2020, in order to meet the anticipated payback.

6.11 Variation in future fuel prices. The RHI payments provide the majority of revenue for the project, and these would be guaranteed for approximately 20 years and index-linked. However, the project payback is also affected, to some extent, by the cost of gas and electricity. All work to date has been based on present day fuel prices.

6.12 Higher capital costs than expected. This risk will be mainly addressed through the competitive tender process and the subsequent detailed design stage.

6.13 Lower revenue than expected. Aside from the RHI tariff rate and fuel prices considerations above, it is important to note that the RHI payments are made based on metered heat usage at each property. Therefore, if the properties are not fully let, the project revenue will be lower.

6.14 Abortive costs. There is a risk of abortive costs if the project doesn't proceed through its respective phases. However, this is unlikely to occur beyond the detailed design work, which makes up a small proportion of the overall costs.

## 7 CONCLUSIONS

Ebley Mill

7.1 Ebley Mill is suitable for installation of a water-source heat pump system, which will have a total cost of approximately £1.05m and provide an $CO_2$ saving of 70-110 tonnes per year. Approximately 80% of the initial capital costs will be recovered through receipt of RHI payments over a period of 20 years. The heat pump system is expected to last for 25 years.

7.2 Given the availability of the Renewable Heat Incentive and the upcoming replacement of the main gas boilers at Ebley Mill, it is now a convenient time to consider progressing with this project. If the project is considered at a later date, there may be difficulties in sourcing parts for the ageing gas boilers, there will be increased pressure to eliminate gas usage, but the RHI will no longer be available. Making use of the RHI now enables SDC to make full use of this valuable incentive from central government.

7.3 In order to achieve the anticipated performance, it is essential that the project progresses quickly to the design & build tender stage. To avoid further tariff reductions, the design will need to be sufficiently advanced to allow a 'Stage 1' Ofgem application to be submitted during September 2020.

7.4 Whilst the capital investment isn't fully paid back over the life of the RHI payment period, the environmental benefits of the installation are also a key consideration. In view of the Council's CN2030 commitment, it is recommended that the Council proceeds with installation of the WSHP at Ebley Mill, subject to the necessary consents being secured. The competitive tender and subsequent design work will provide more certainty on the project costs and performance, before any more significant project costs are incurred.

Brimscombe Port Mill

7.5 Brimscombe Port Mill is suitable for installation of a water-source heat pump system, which will have a total cost of approximately £380k and provide an $CO_2$ saving of 27-46 tonnes per year. All of the initial capital costs will be recovered through receipt of RHI payments over a period of 20 years. The heat pump system is expected to last for 25 years.

7.6 Given the availability of the Renewable Heat Incentive and the upcoming relocation of the gas boilers to accommodate the redevelopment of Brimscombe Port, it is now a convenient time to consider progressing with this project. If the project is considered at a later date, there will be increased pressure to eliminate gas usage, but the RHI will no longer be available. Making use of the RHI now enables SDC to make full use of this valuable incentive from central government.

7.7 In order to achieve the anticipated performance, it is essential that the project progresses quickly to the design & build tender stage. To avoid further tariff reductions, the design will need to be sufficiently advanced to allow a 'Stage 1' Ofgem application to be submitted during September 2020.

7.8 In view of the Council's CN2030 commitment, it is recommended that the Council proceeds with installation of the WSHP at Brimscombe Port Mill, subject to the necessary consents being secured. The competitive tender and subsequent design work will provide more certainty on the project costs and performance, before any more significant project costs are incurred.

## 8 FURTHER WORK

8.1 In anticipation of needing to meet RHI deadlines the district council has procured a consultant to write the client's requirements and prepare the tender documents for the design and install contracts. WDS have been appointed and have prepared a set of Employer's Requirements to enable competitive tenders for the design and installation to be sought.

8.2 Minor testing work as part of the Ebley Mill feasibility study by Renewables First is still outstanding due to COVID-19 delays. This will be carried out when possible, with results incorporated into the tender documents.

8.3 Due to the urgency of submitting consent applications and the relatively low cost associated with this, this will be carried out prior to the main design & install contract.

8.4 The design and installation contracts would include the following steps:

- Thermal simulation of buildings to finalise the heat demand profile
- Design & specification of the heat pump systems and radiator upgrades
- Installation & commissioning, including RHI accreditation

## 9 IMPLICATIONS

Financial Implications

9.1 The Council's capital strategy requires that all recommendations to Council for new capital schemes include consideration of financials, strategic objectives, capacity and deliverability. All of these issues have been addressed with the report and associated feasibility studies.

9.2 As a new addition to the capital programme, and one which is supported by a future revenue stream, borrowing has been identified as the most appropriate funding source. Whether this is external borrowing or borrowing from internal cash resources is at the discretion of the S151 Officer within the limits of the approved Treasury Management Strategy.

9.3 As a scheme funded by borrowing, the impact on the Council's annual revenue budget is a combination of Minimum Revenue Provision (spreading the capital cost over asset life) and interest on the borrowing. For the two schemes proposed the provisional costs of these have been calculated on an annuity basis to give an estimate of the annualised cost over 25 year terms. The exact annual cost may vary. On the day of writing the interest available on 25 year loans through the Public Works Loan Board was 2.4% and that rate has been used in the calculations.

Table 3

| | **Ebley Mill** | **Brimscombe Mill** |
|---|---:|---:|
| Annual Saving (see table in report) | 41,969 | 20,050 |
| MRP and Interest | (56,105) | (20,550) |
| **Annual Budget Impact** | **(14,136)** | **(500)** |

9.4 Table 3 clearly reflects, as shown elsewhere in the report, that the Brimscombe project is effectively self-funding whilst the Ebley Mill project requires a financial subsidy (although delivers environmental benefits). It is proposed to use the climate change reserve to meet the annual revenue cost at Ebley Mill until the medium term financial plan becomes clearer. The estimated annual cost of the Brimscombe project can be met by existing budgets.

9.5 Calculations shown that part funding the Ebley Mill Scheme with £263k of the capital reserve would produce a net zero impact on the Council budget. This approach will be considered by the S151 Officer upon final financing of the project but is not currently recommended as it effectively frontloads the net Council subsidy required and does not allow for the benefit of the time value of money reducing MRP impact in future years.

9.6 Should either building be sold in the next 25 years the first use of any capital receipt will be to repay any outstanding capital costs from these schemes.

9.7 The decision being taken by the committee will only allow the scheme to proceed if there is a successful application to the RHI which helps to limit the financial risk.

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Legal Implications

9.8 Any specific legal implications arising from the technical aspects of the scheme in terms of consents and licences are set out in the body of the report. On the basis that the purpose of the recommendation in this report is to ask Council to add this scheme into the capital programme, there are no additional legal implications. In due course, there will be procurement requirements to be met which must comply with the Contract Procedure Rules but there are tight timescales to be managed as set out above.

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Equality Implications

9.9 There are no specific changes to service delivery proposed within this decision.

Environmental Implications

**Ebley Mill**

9.10 The WSHP at Ebley Mill would be replacing boilers within a decade of their expected lifecycle. Given that the outlook on plans to decarbonise the grid is that gas boilers will be phased out from 2025 it therefore seems reasonable that an early replacement to allow advantage of incentives designed to ease this transition is taken advantage of. It is noted the new equipment would have a lifecycle of 25 years before replacement needs consideration, which is a good lifecycle duration.

9.11 The existing boilers at Ebley Mill will be stripped down and harmful materials suitably removed under licence before being disposed of for recycling and reprocessing of materials.

9.12 The WSHP will be providing heat at a much greater efficiency of 400% compared with the existing gas boilers (approximately 85%) and given the fabric issues on the aged Ebley Mill it is anticipated that it would return a carbon saving at the higher end of the estimate of 70 -110 tonnes per year.

9.13 The WSHP installation proposal is complementary to our Carbon Neutral 2030 commitment and, given the listed building status and context of the building the viable alternatives for heating supply are limited. Biomass is a potential solution but requires ongoing deliveries and storage space and there is a question as to whether local supply chains are well enough developed at this time.

9.14 The tender documentation includes for the successful contractor to liaise with the Statutory authorities and all license applications.

9.15 The Ebley Mill WSHP would provide a $CO_2$ saving of 70-110 tonnes per year, with a system lifetime of approximately 25 years.

**Brimscombe Port Mill**

9.16 The replacement of 3 relatively new gas boilers on this site requires some consideration of life cycle cost. Taking into account the efforts and materials required to re-site them from their current location and the commencement of phasing out of gas boilers from 2025 replacement with new technology is considered reasonable.

9.17 In the first instance consideration will be given to the possibility of re-using the boilers from Brimscombe Port Mill and installing in a Council owned building. Should this prove to be either uneconomic or installation is not compatible with those buildings they will be offered for sale and use by others.

9.18 Regardless of the age of the current system the new technology offers much better efficiency and a significant carbon saving. The Brimscombe Port Mill WSHP would provide a $CO_2$ saving of 27-46 tonnes per year, with a system lifetime of approximately 25 years.

9.19 Enhancements to the fabric of the Brimscombe Port Mill in particular are to be included within the builders' works package to improve the insulation of the external elements and reduce heat loss (including additional loft insulation, draft proofing and secondary glazing).

9.20 The tender documentation includes for the successful contractor to liaise with the Statutory authorities and all license applications.

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# Port Mill

## Water-source heat pump feasibility study

| Ref: | Issue: | Date: | Lead author: | Approved by: |
|---|---|---|---|---|
| PORTM_HPFS | 02<br>03<br>04 | 08/10/2019<br>29/04/2020<br>06/05/20 | WH | Philip Davis – Managing Director |

# Contents

# Introduction

**Executive summary**

This report summarises the feasibility of a water-source heat pump installation at Port Mill. The site is due for redevelopment shortly, which will require the plant room to be relocated, providing an opportunity to upgrade and decarbonise the heating system.

Our assessment reviews the available resource, heating demand and existing emitters, before recommending an outline system specification and next steps to progress the project.

Overall, the project would enable a CO2e reduction of 60-100% (27-46 tonnes per year) with a payback period of 14.5 years. In order to avoid further RHI rate reductions, the project would need to progress very quickly to obtain the necessary consents during the Jul-Sep tariff period.

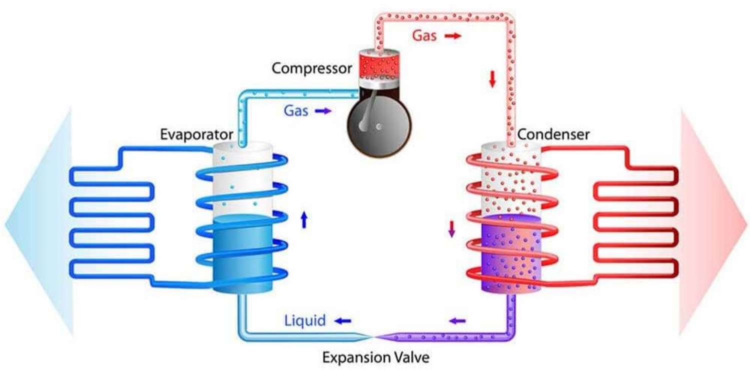
**Heat pump technology**

Heat naturally flows from hot to cold. A heat pump is a device that moves heat in the opposite direction: it pumps heat from a cooler 'source' to a warmer 'sink'.

Domestic fridges use this principle to transfer heat from the interior into the surrounding room. In a similar way, it is possible to transfer heat from the external environment into a building's heating system.

The most common type of heat pump is an electrical compression heat pump. The heat pump works by allowing a refrigerant to absorb heat, which causes it to evaporate, then using electricity to compress the refrigerant, which causes it to condense and release its heat. This allows heat to be moved, by absorbing it from one location and releasing it in another.

Figure 1 – Heat pump operation




All heat pumps operate most efficiently when the source and sink temperatures are similar. This is characterised by the coefficient of performance (COP), which is the ratio of heat power output and electrical power input.

Rivers, lakes, and water bodies are heated by the sun and so provide a source of renewable heat that can be used in homes and businesses. Water has a high heat capacity and a relatively stable temperature throughout the year, which results in water-source heat pumps typically having a much higher COP than air- or ground-source heat pumps.

Most water-source heat pump systems use a 'closed loop' to circulate a thermal transfer fluid (antifreeze mixture) between the heat pump and the water. Inside the heat pump, heat exchangers transfer heat to the refrigerant and then on to the building heating system.

'Open-loop' systems that abstract water are possible, however water quality issues mean an intermediate heat exchanger is required, with higher maintenance requirements. These systems are generally not recommended.

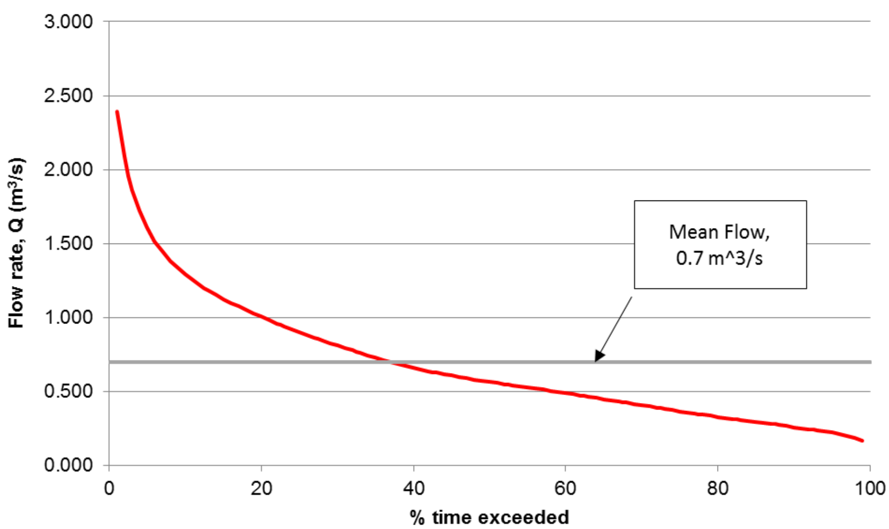
## Resource

**Watercourse flow**
The Frome was gauged at Chalford during 2005-8, with mean flow 0.34 $m^3/s$ and catchment size 57.5 $km^2$. Using this, the 76 $km^2$ catchment at Brimscombe Mill gives an estimated mean flow of 0.45 $m^3/s$. However, no recent information could be found on this gauging station, which may have been discontinued.

The Frome has been gauged at Ebley Mill since 1969, with mean flow 2.59 $m^3/s$ and catchment size 198 $km^2$. Using this, the 76 $km^2$ catchment at Brimscombe Mill gives an estimated mean flow of 0.99 $m^3/s$. Due to the long measurement period this is considered to be more accurate.

We estimate the mean flow at the site as 0.7 $m^3/s$ +- 0.2 $m^3/s$. Figure 2 shows the flow duration curve.

Figure 2 – Flow duration curve

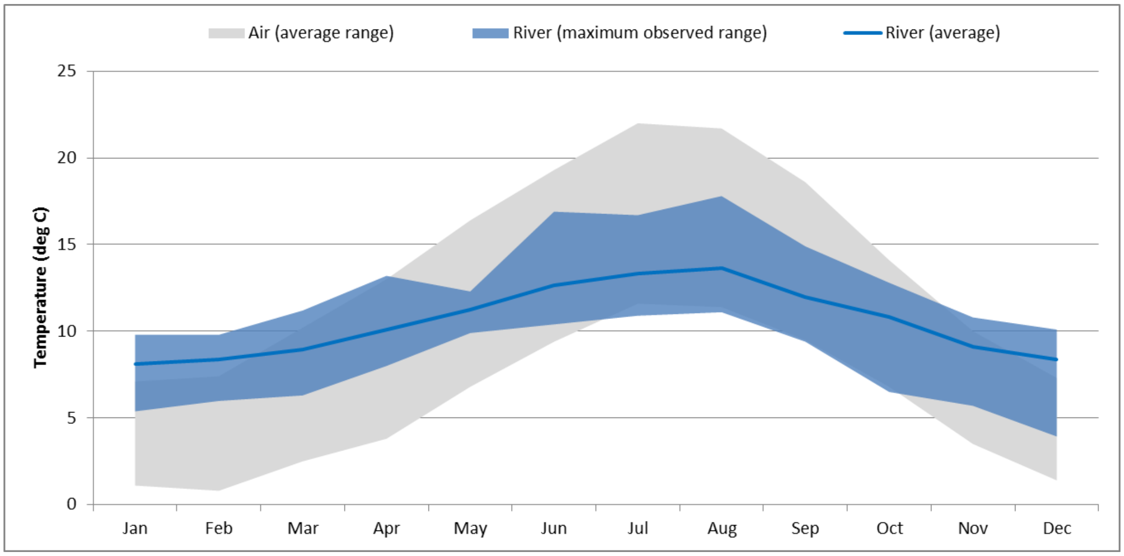



Environment Agency guidance stipulates a maximum drop in river temperature of 2 degrees. The graph above indicates that the lowest flow expected at the site is around 0.2 m3/s. This is the 'Q99' flow i.e. will be exceeded 99% of the time. Reducing 0.2 $m^3/s$ by 2 degrees would yield around 840 kW. It is therefore very unlikely that low river flow will limit heat power here.

**Climate & river temperature**
Air and river temperature data were obtained as follows. The findings are shown in Figure 3.

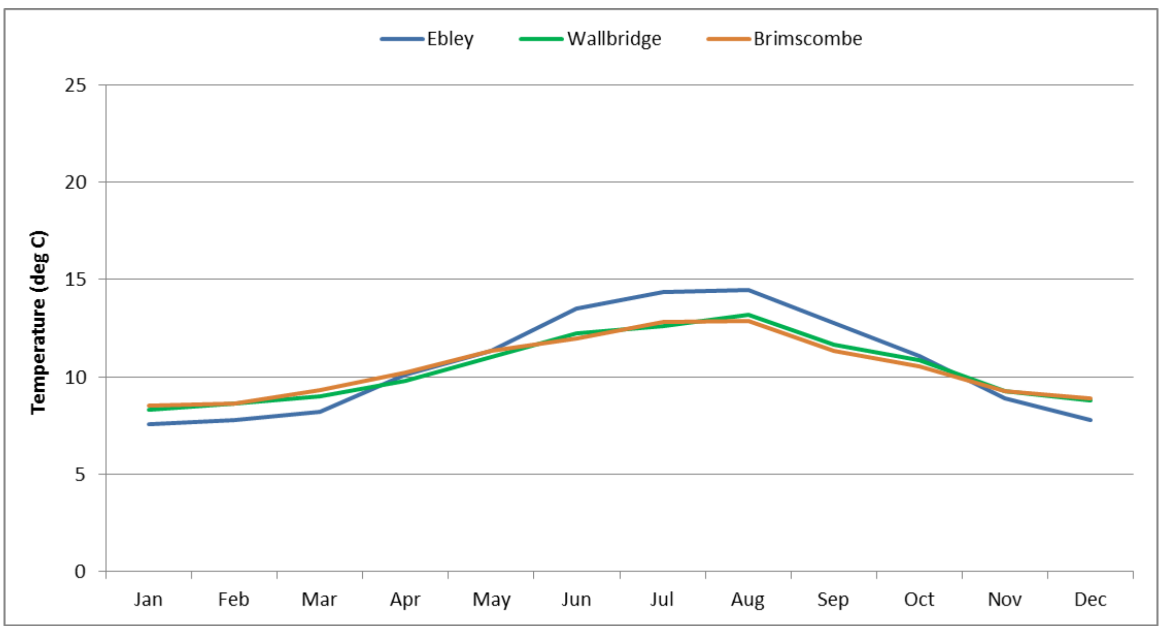
| Parameter | Data type | Source | Period | Location |
|---|---|---|---|---|
| Air temperature | Daily min/mean/max | Met Office | 1981-2010 | Cirencester |
| River temperature | Spot measurements | EA 'WIMS' | 2000-2015 | Ebley, Brimscombe, Wallbridge |

Figure 3 – Local temperature data




As shown in Figure 4, more extreme temperatures are seen at Ebley than at Brimscombe and Wallbridge. This may be due to contributions from the Painswick and Nailsworth streams, or site-specific factors such as shading.

Figure 4 – Comparison of average river temperature by location

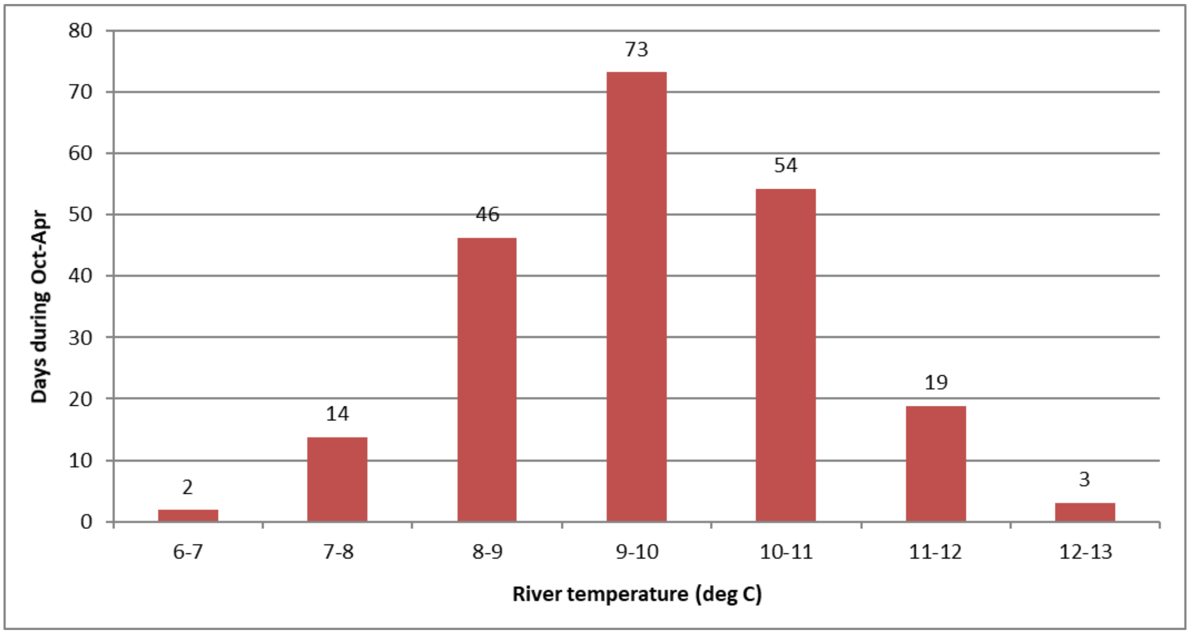



Of the readings taken at Brimscombe, the lowest temperatures recorded are:

| Date / time | Temperature (C) |
|---|---|
| 08/01/13 10:55 | 6.80 |
| 04/02/09 11:55 | 7.17 |
| 09/01/09 15:10 | 7.33 |

In summary, the local temperature data show that river temperature often falls to around 7 degrees C during Dec-Jan. Using a Gaussian model, we estimate that the following distribution on average during the main heating period:

Figure 5 – River temperature: days per heating season (Oct-Apr)




During periods when the river temperature is low, the heat pump will continue to work effectively, however the efficiency will be reduced. Details of the coefficient of performance are given later in this report.

As the river is relatively fast-flowing, it is well-mixed and there is no significant variation in water temperature across the site. This was confirmed by on-site measurements during summer 2019.

## Building details

**Construction**
'Port Mill' or 'The Mill', dates from the early 19th century when it was used as a cloth mill. It is Grade II listed both for architectural reasons as a high-quality stone-built mill and for historic reasons given its background in local canal and textile traditions.

The building has three storeys with three main sections:

| | |
|---|---|
| **East wing** | Next to the river (11 x 15 m) |
| **South wing** | Extends to the SW (24 x 9 m) |
| **West wing** | Extends to the NW (21 x 11 m) |

**Total floor area** including communal areas: 1,800 $m^2$
**Total volume** including communal areas: 5,400 $m^3$

The limestone walls are around 450 mm thick and include large single-glazed windows with small panes and metal frames. The building has a suspended floor and a pitched slate roof. Approximately 200 mm of insulation (conductivity 0.044 W/mK) was recently fitted across most sections of the floor of the roof cavity, which would give it a theoretical U-value of around 0.2. However, there are several uninsulated sections used as walkways or for storage, so in practice the U-value may be higher than this. It is unclear whether there is also a gap below the boarded floor in the roof cavity, which could lead to significant ventilation losses.

An EPC assessment was carried out in 2009 and returned a D rating.

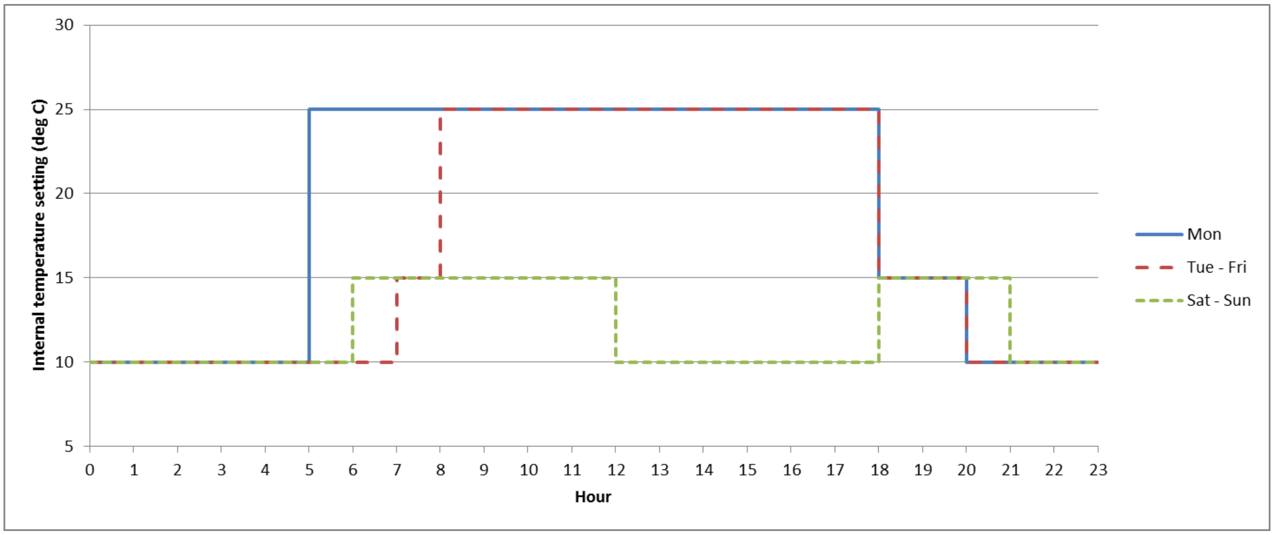
The Brimscombe Port area is planned to be completely redeveloped, with construction expected to start in the next 1-2 years. As a result, the plant room location will need to be moved, providing an opportunity to make cost-effective improvements to the heating system.

**Heating system**
The plant room is currently situated in 'The Old Port House', a separate building north-east of the main building entrance. This building will be demolished; the plant room will be moved to the main mill building, exact location to be confirmed.

*Existing heating equipment:*

| ***Equipment*** | ***Specification*** | ***Notes*** |
|---|---|---|
| ***Gas boilers*** | *3 x 120 kW* Strebel S-CB boilers (gas)<br>Manufacturer's gross seasonal efficiency 96%<br>EESI Ltd 2016 test gross efficiency 88% | Flow temperature 75C |
| **Hot water heater** | 19.5 kW Andrews RFF 190<br>Manufacturer's gross efficiency 63%<br>EESI Ltd 2016 test gross efficiency 82% | Flow temperature 50-55C |
| **Radiators** | High temperature<br>Mostly 40 x 110 cm 1p / 60 x 160 cm 2p<br>All radiators fitted with TRVs | Approximately 15 kW total output per office |
| **Control system** | Dated system<br>No zoning controls<br>Internal and external temperature sensors | Location of internal sensor unclear<br>Weather compensation set to ON/OFF only<br>Heating pattern shown in figure below |

Figure 6 – Existing heating control pattern




**Heat demand**

Occupancy

The building was recently fully occupied with the exception of the ground floor west wing, with approximately 60 staff working full-time Mon-Fri (max. occupancy 120). Currently, only the east and south wings of the ground floor are occupied. All communal areas are heated with the exception of the rear stairwell, where The Chapel adjoins the main building. The Chapel has a separate heating system.

Hot water demand

The peak hot water demand is estimated as 19.5 kW in line with the existing hot water heater.
The average hot water demand is estimated as:

| Occupancy | Usage (litres/day) | Temperature rise (deg) | Daily usage (kWh) | Working days per year | Annual usage (kWh) |
|---|---|---|---|---|---|
| 60 | 8 | 45 | 25 | 253 | 6,325 |

Space heating overview

Space heating can be broken down as:

*Emitter heat power + casual heat gain rate + solar heat gain rate = Fabric heat loss rate + ventilation heat loss rate*

Casual heat gain rate (occupancy = 60):

| Item | Number | Unit heat gain rate (W) | Total heat gain rate (kW) |
|---|---|---|---|
| Lighting in use | (500 $m^2$) | (20 $W/m^2$) | 10.0 |
| Computers in use | 70 | 100 | 7.0 |
| Occupants | 60 | 90 | 5.4 |
| Fridges | 6 | 150 | 0.9 |
| Photocopiers in use | 1 | 800 | 0.8 |
| Printers in use | 4 | 100 | 0.4 |
| **TOTAL** | | | **24.5** |

Solar heat gain rate (winter average):

| Aspect | Area ($m^2$) | Number | Unit heat gain rate ($W/m^2$) | Total heat gain rate (kW) |
|---|---|---|---|---|
| NE/NW-facing | 2.1 | 15 | 39 | 1.2 |
| SE/SW-facing | 2.1 | 18 | 60 | 2.3 |
| **TOTAL** | | | | **3.5** |

Fabric heat loss rate:

| Element | Description | Area ($m^2$) | U-value ($W/m^2K$) | Heat loss rate (kW/K) |
|---|---|---|---|---|
| Windows | Single pane, metal frames | 179 | 5.2 | 0.93 |
| Walls | 450mm limestone | 1395 | 1.4 | 1.95 |
| Roof | 200mm insulation (80% coverage) | 603 | 0.3 | 0.18 |
| Floor | Suspended timber | 574 | 0.5 | 0.29 |
| Doors | Solid wood | 24 | 2 | 0.05 |
| **TOTAL** | | | | **3.40** |

Please note the figures above do not include losses due to thermal bridging or ground conduction.

Ventilation heat loss rate & overall demand:

The ventilation heat loss rate depends on the number of air changer per hour (ACH), which can only be directly measured using infiltration testing. To estimate the ACH value, the fabric heat loss rate was compared with existing overall consumption based on gas bills, using degree-day analysis.

***Degree-day analysis explained***

*Degree-day analysis is a method for estimating energy demand (kWh) over a certain period using external temperature data. During each day, the number of degrees C of heating required changes as the external temperature changes. This heating requirement is summed up across the day, with units of 'degree-days'.*

*Due to casual and solar gains, the heating requirement can be zero even if the external temperature is slightly below the target internal temperature. The external temperature at which the rate of casual and solar heat gain equals the heat loss rate is called the 'base temperature'. At this site the total heat gain rate is 28 kW and total heat loss rate is 9.1 kW/K. Using the proposed internal 'high' temperature of 21 C, this means the base temperature is 21 – (28 / 9.1) = 17.9 C.*

*Degree-days are then calculated relative to the base temperature, and multiplied by the total heat loss rate (14.4 kW/K) to give a total energy demand figure in kW-days. This is multiplied by 24 to give the result in kWh.*

Please also note:

- The ground floor west wing (L0 west) was unoccupied during the period of gas bills reviewed. When matching the model with historical data, the effect of this empty office was approximated by ignoring heat losses from this area.
- A gas-to-heat efficiency of 90% was assumed
- This analysis assumes that ACH is constant, whereas in reality it will vary according to factors such as wind speed/direction, occupant behaviour and internal/external temperature

The model gives the closest fit with gas bills data when ACH is set to 3.2, as shown in Figure 7.

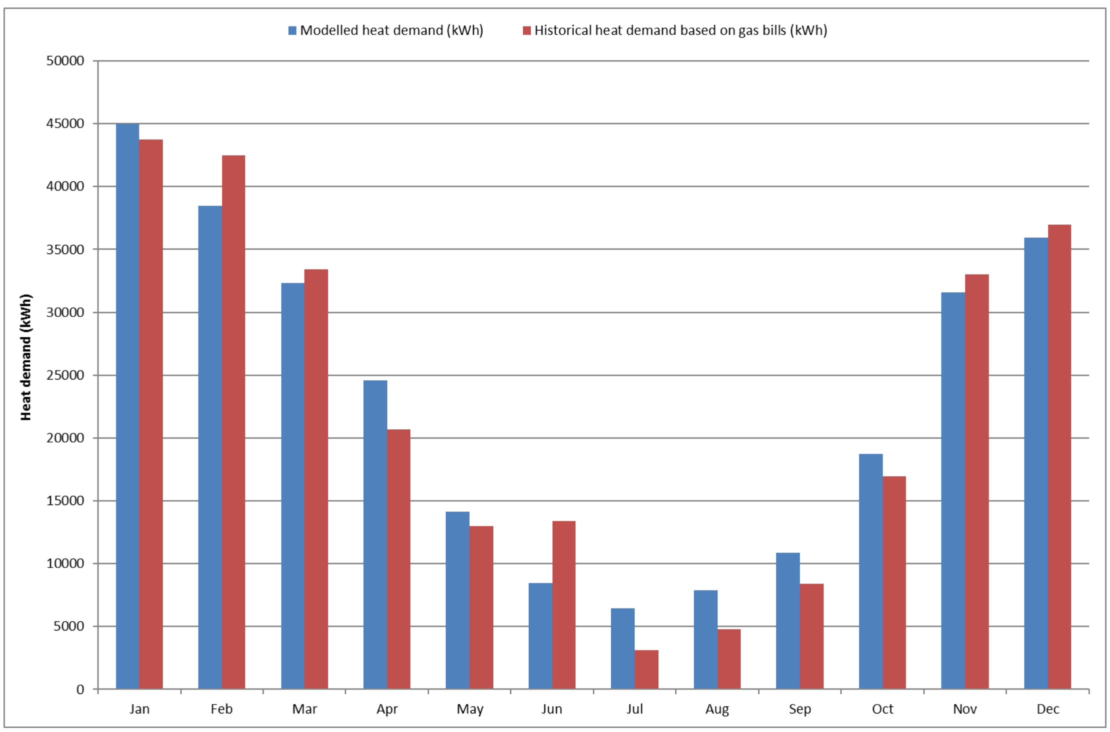
The low historical usage in Jul-Sep may be due to underestimation of solar gains, which were modelled using typical winter values. The high historical usage in June is likely to be an anomaly as the gas bill in June 2013 was particularly high.

Including heat losses in L0 west in this model (i.e. assuming this area is occupied), the overall peak space heating demand is 265 kW, based on an internal temperature of 25C and external temperature -4C. Setting solar gain to zero (which is conservative) and subtracting 25 kW of casual gains, the net peak space heating demand is **240 kW**. This is noticeably lower than the capacity of the existing boilers, which is 320 kW. There are two likely reasons for this:

1. A larger capacity has been used to reduce warm-up times
2. The boilers have been over-sized as a contingency measure

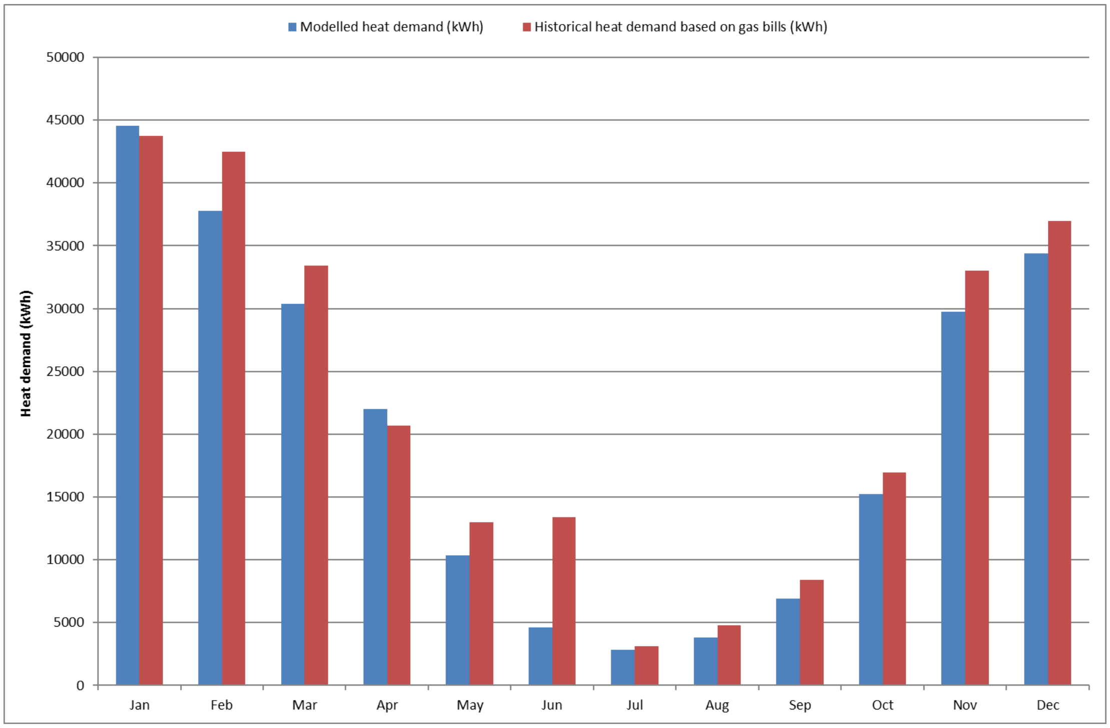
To demonstrate the first point: the overall heating system has a volume of around 1,500 litres. Heating from 10C to 75C at 150kW would take approximately 45 minutes, so a larger capacity of around 300kW would arguably be worthwhile to reduce the warm-up time to 23 minutes.

Figure 7 – Existing monthly heating profile




The predicted future heating profile was adjusted slightly to set the 'high' internal temperature to 21C instead of 25C. All offices were assumed to be heated, including L0 west, with the occupancy remaining at 60. All other factors were unchanged. This gives the modelled heating profile as shown in Figure 8.

Figure 8 – Predicted monthly heating profile




The predicted overall section-by-section heat loss rates are as shown below:

| Section | Fabric (kW/K) | Ventilation (kW/K) | Total (kW/K) | Total (kW) |
|---|---|---|---|---|
| L0 east | 0.25 | 0.27 | 0.52 | 13 |
| L0 south | 0.42 | 0.56 | 0.97 | 24 |
| L0 west | 0.35 | 0.62 | 0.98 | 24 |
| L0 communal | 0.17 | 0.38 | 0.56 | 14 |
| L1 east | 0.24 | 0.34 | 0.59 | 15 |
| L1 south | 0.38 | 0.59 | 0.97 | 24 |
| L1 west | 0.27 | 0.63 | 0.90 | 22 |
| L1 communal | 0.11 | 0.40 | 0.51 | 13 |
| L2 east | 0.28 | 0.39 | 0.66 | 17 |
| L2 south | 0.44 | 0.60 | 1.04 | 26 |
| L2 west | 0.37 | 0.62 | 0.99 | 25 |
| L2 communal | 0.12 | 0.32 | 0.43 | 11 |
| **TOTAL:** | **3.40** | **5.73** | **9.13** | **228** |

As shown above, the predicted peak space heating demand is 228 kW, based on an internal temperature of 21C and external temperature -4C. This figure ignores any gains so overestimates the actual demand. Subtracting casual gains (but ignoring solar gains, which are intermittent), the net peak space heating demand is **204 kW**. The total including hot water requirements is therefore **224 kW**.

Summary of heating demand

| | | Existing | | Proposed |
|---|---|---|---|---|
| **L0 west status** | | Unoccupied | Occupied | Occupied |
| **Maximum internal temperature (C)** | | 25 | 25 | 21 |
| | | | | |
| **Space heating** | **Annual (kWh)** | 274,100 | 307,000 | 242,300 |
| | **Peak (kW)** | 212 | 240 | 204 |
| | | | | |
| **Hot water** | **Annual (kWh)** | 6,300 | 6,300 | 6,300 |
| | **Peak (kW)** | 20 | 20 | 20 |
| | | | | |
| **TOTAL** | **Annual (kWh)** | 280,400 | 313,300 | 248,600 |
| | **Peak (kW)** | 232 | 260 | 224 |

As discussed above, the ventilation rate has been estimated by matching the model to historical gas bills. These bills show a consumption of around 319,000 kWh per year. Applying a 90% efficiency reduces this to 287,500 kWh delivered in total, of which 6,300 kWh is hot water and 281,200 kWh is space heating. There may also be a small amount of additional heat loss via pipework in the plant room or other unheated areas.

**Emitters**

Theoretical radiator outputs for part of the property are shown below. Each radiator type is categorised according to the number of panels (p), number of convectors (c) and its dimensions.

| **Type** | **1p 1c** | **1p 1c** | **1p 1c** | **2p 2c** | **2p 2c** | **1p 1c** | **2p 2c** | **2p 1c** | **1p 1c** | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Height (m)** | **0.46** | **0.46** | **0.46** | **0.46** | **0.46** | **0.60** | **0.60** | **0.46** | **0.60** | |
| **Length (m)** | **1.20** | **1.49** | **1.64** | **1.20** | **1.49** | **1.65** | **1.65** | **1.49** | **0.88** | |
| | | | | | | | | | | **TOTAL** |
| **L0 south** | | | | | | | | | | |
| Number | 7 | | 5 | | | | | | | |
| Power (kW) | 7.60 | | 7.42 | | | | | | | **15.0** |
| | | | | | | | | | | |
| **L0 west** | | | | | | | | | | |
| Number | | 2 | | 3 | 3 | | | | | |
| Power (kW) | | 2.70 | | 5.56 | 6.91 | | | | | **15.2** |
| | | | | | | | | | | |
| **L0 com.** | | | | | | | | | | |
| Number | | | | | | 1 | 2 | 1 | 1 | |
| Power (kW) | | | | | | 1.85 | 6.32 | 1.91 | 0.99 | **11.1** |

Based on these figures, the radiators appear to only be capable of delivering approximately 150 kW across the property. However, in January 2020, a test of the heating system was carried out to provide further information on this. The results suggested that the radiators are capable of emitting a greater output and are unlikely to be a significant limiting factor in heat delivery for the building.

**Energy efficiency improvements**
Any energy efficiency improvements will be valuable not only by reducing heating requirements but also by allowing lower flow temperatures to be used, which will improve heat pump efficiency.

As part of this assessment it has been assumed that the internal temperature will be reduced to 21C. As shown above, this will reduce the space heating demand by approximately 27,000 kWh or 10%.

We estimate that over 60% of heat losses in the building are via ventilation, so infiltration testing and draught-proofing is recommended. A reduction in air change rate of 25% would reduce energy usage by around 15%. Other improvements that should be considered include secondary glazing, with panels fitted inside the window alcoves, and additional loft insulation, particularly to fill any gaps.

No improvements to airtightness or insulation have been assumed as part of this assessment.

## System design

**Emitters**

Although heat pumps are capable of delivering high flow temperatures, it is generally more cost-effective to use a lower flow temperature and replace the radiators with low-temperature models.

Using the existing radiators with a flow temperature of 45C instead of 75C would reduce their output by approximately 70%. Whilst the existing radiators at 75C can maintain an internal temperature of 21C during an external temperature of around 2C, reducing the flow temperature to 45C would mean the heating is insufficient below 13C.

Replacing the radiators with low-temperature models is relatively straightforward. The existing 460 x 1200mm 1p1c radiators provide around 1086 W at a flow temperature of 75C; a low temperature model (Jaga Strada DBE) measures 500 x 1000mm and provides 1143 W at 45C. Low-temperature radiators also warm up much more quickly than traditional steel radiators.

The number and size of emitters does not need to change significantly as a result of the heat pump installation. The new radiators will be able to transmit the full output from the heat pump.

**Heat pump sizing**

The heat pump size affects various factors including efficiency, carbon savings, RHI payments and practicalities. A smaller system would be less expensive but would require bivalent operation (alongside retained gas boilers) whereas a larger system could provide the entire heating load.

If a bivalent system is used, there will be a certain external temperature below which the heat pump is insufficient and backup heating is required. There will also be a certain temperature at which the backup heating would be more cost-effective.

In terms of cost, even at very high flow temperatures the heat pump will provide a COP of around 2, which corresponds to a running cost of around 7 p/kWh. Including the RHI, the effective running cost is around 4 p/kWh. It is therefore likely that using the heat pump will always be cheaper than using the gas boilers, at least during the RHI period.

To ensure the maximum possible carbon reduction, we recommend heating the building entirely using heat pumps. Three 75 kW heat pumps would have an actual output of 225 kW (@ river 6C) and would provide 100% of the annual heat usage. The actual output would also be noticeably more at around 270 kW. This arrangement helpfully also avoids the need for a new gas supply in the relocated plant room.

We recommend specifying an additional smaller heat pump to provide hot water for the site. Although the existing heater is rated at 19.5 kW, a slightly lower rated capacity may be suitable. For example, the Kensa Evo 15 kW has a higher COP than larger models but can still provide 18.8 kW at 50C and a lower output at up to 63C.

**Collector specification**

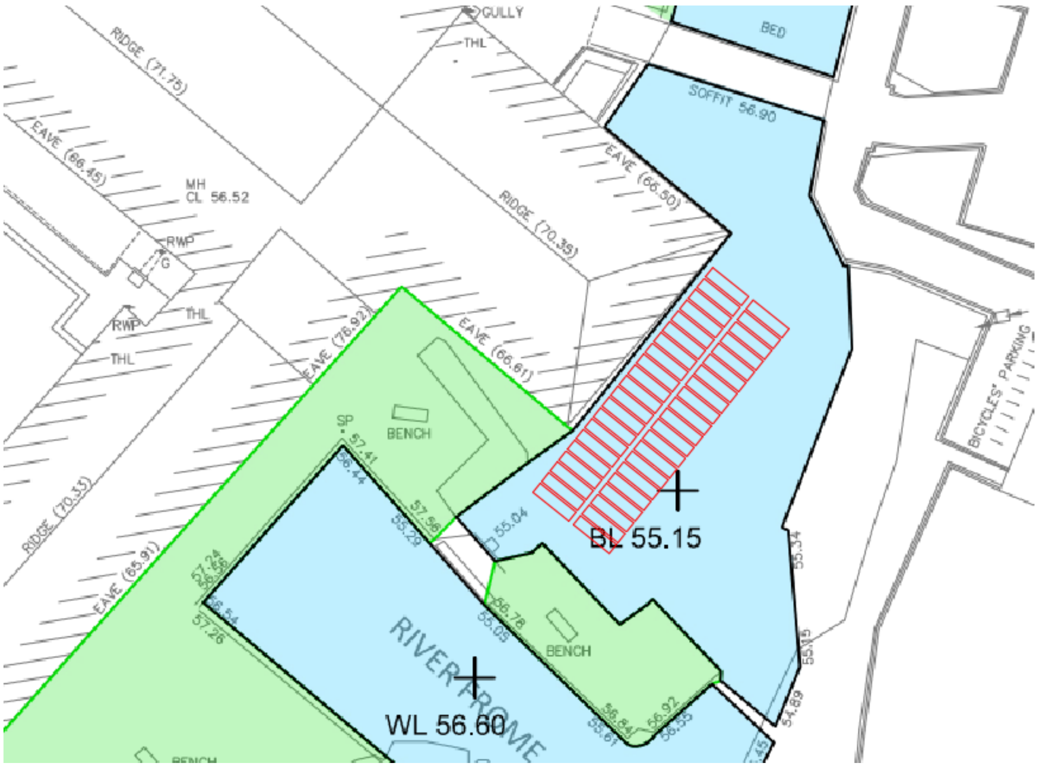
There are two types of heat collector commonly used for water-source heat pumps: HDPE ‘pond mats’ and steel flat plate collectors. In this case, we recommend the use of flat plate collectors, which are smaller and better-suited to sites with flowing water.

Some flat plate collectors (e.g. ‘SlimJim’) consist of several plates mounted vertically on a single frame. Whilst these have a small footprint, we would recommend that flat plates are mounted against the channel bed or walls only, to avoid ongoing maintenance issues due to debris.

We are currently prototyping and testing a flat plate heat collector that can be mounted in this way, which will enter the market shortly. Our results indicate that the collector plates will provide approximately 6 kW per $m^2$, based on a 6C river temperature and the typical river speed at the site of 0.1-0.2 m/s. Therefore, to provide 225 kW a total collector area of approximately 40 $m^2$ would be required.

An example layout is shown in Figure 9. This avoids interaction with the Brimscombe Port redevelopment.

Figure 9 – Suggested collector layout



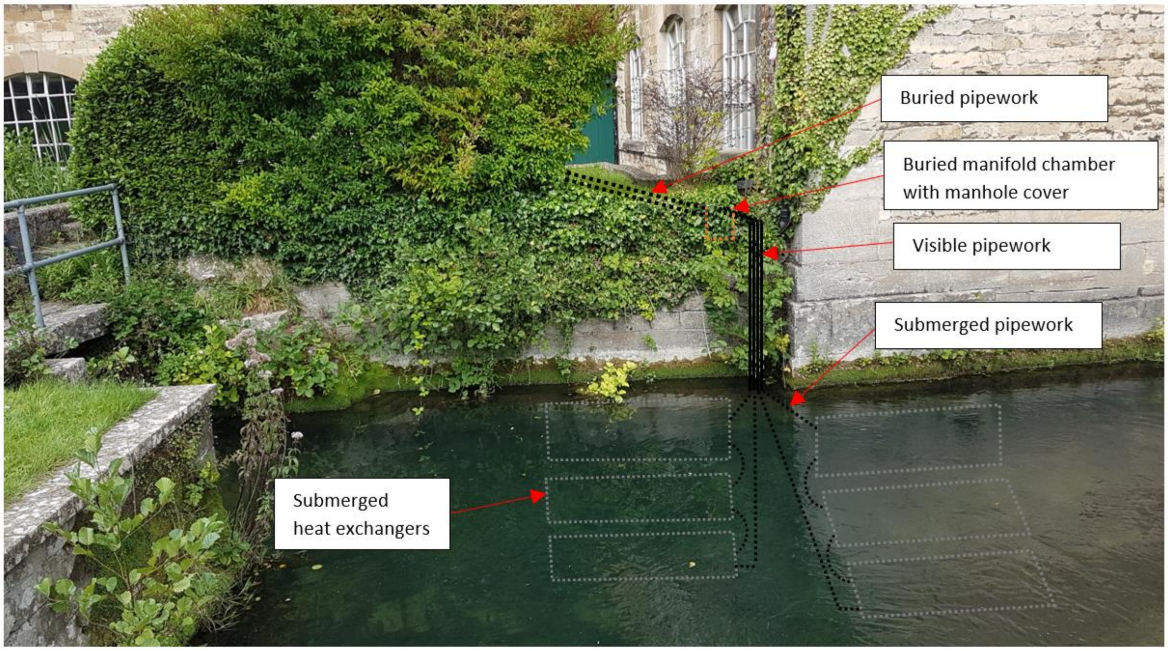

The overall collector loop flow rate would be approximately 10 litres/second. The flow rate through each collector plate should be approximately 1 litre/second; the plates would be arranged into ten groups accordingly. Within each group the collectors would be connected in series, whilst overall the groups would be connected in parallel.

The collectors will be mounted on a steel frame and secured using ground anchors.

If the collector footprint is considered too large, an alternative is to use an open-loop heat pump system. These are uncommon as they require intake filters and an additional heat exchanger that needs to be maintained and replaced quite regularly. However, the visual impact would be smaller. An abstraction rate of around 13 litres per second would be required. This has not been considered further in this report.

**Collector pipework**

Pipework would pass from the collectors into an underground manifold chamber on the bank. From here, larger diameter flow/return pipes would carry the glycol mixture to the plant room. An example routing is shown below:

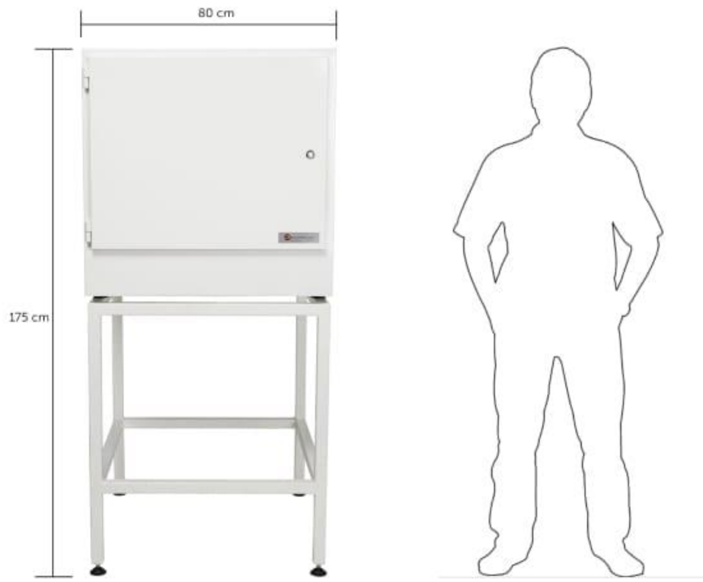



Suggested pipe diameters and pressure loss calculations are as shown below. The power required for circulation pumping is discussed later in this report.

| **Element** | **Flow rate** | **Pipe OD** | **Flow speed** | **Length** | **Pressure drop** |
|---|---|---|---|---|---|
| | l/min | mm | m/s | m | mWs |
| Collectors | | | | | 2.55 |
| Pipes to manifold | 60 | 40 | 1.2 | 15 | 1.95 |
| Manifold to plant room | 600 | 110 | 1.6 | 25 | 1.30 |
| Elevation changes | | | | | 3.00 |
| Additional bends/fittings | | | | | 1.50 |
| | | | | **TOTAL** | **10.30** |

**Grid connection**
The new plant room area will be in the main mill building, exact location to be confirmed. To minimise circulation pumping, it would ideally be on the ground floor. Heat pumps are a similar size to gas boilers: a 75 kW heat pump is shown below as an example:

Figure 10 – Heat pump size diagram




The maximum import capacity of the grid connection is currently unknown. The heat pump will require an import capacity of at least one-third of the rated heat power output. A 225 kW heat pump system would require approximately 75 kW.

**Metering**
Electricity is currently metered both for the site as a whole and also individually for each tenant. Heating is not currently re-billed to tenants individually. If this general arrangement continues, the council would pay for the electricity required to run the heat pump and would also receive the full benefit of the RHI payments. However, other charging structures could be considered.

The heat pump system will include a MID-approved heat meter, which is a requirement for claiming RHI payments.

**Control system**
A dedicated control system will be provided by the heat pump manufacturer. We recommend adjusting the 'high' internal temperature setting to 21C and using weather compensation that adjusts flow temperature based on the external temperature.

**Predicted performance**
The performance of the heat pump system is shown below, based on 3no. Kensa P750-H with a total rated capacity of 225 kW. This assumes heating to 45C and ignores any auxiliary power requirements such as circulation pumping.

| River temperature (C) | Heat power output (kW) | Coefficient of Performance (COP) |
|---|---|---|
| 6 | 270 | 3.72 |
| 8 | 288 | 3.90 |
| 10 | 308 | 4.07 |

This shows that the heat power output will generally be significantly above the nominal rated capacity. Based on the minimum river temperature of 6C, a nominal heat pump rating of 225 kW would actually deliver 270 kW output.

The seasonal coefficient of performance (SCOP) for the heat pump across the year is estimated as 3.8. This reflects the stable river temperature at 9-10C, but also that the heat pump may be required to operate slightly above 45C in order to achieve 45C at the radiators, due to heat losses, cold water mixing and so on.

The circulation pumping requirement, based on the pressure drop stated above, is estimated as 2.1 kW. This will apply whenever the heat pump is operating. The proportion of time that the heat pump and circulation pump are operational can be approximated to the capacity factor, which for the overall system is 11%. This equates to 2,100 kWh for circulation pumping. The total heat delivered is around 242,300 kWh, so if this is done at a SCOP of 3.8 the electricity used for the heat pumps is 63,800 kWh. Adding circulation pumping increases the electricity usage to 65,900 kWh, bringing the SCOP to 3.7. This adjusted figure is usually instead referred to as the seasonal performance factor (SPF).

There will be some additional auxiliary loads that will reduce the SPF a little further, however these are relatively minor so have not been assessed here. The overall SPF is estimated as 3.5.

# Environment & consenting

**Environmental impacts**

During installation, the river bed will be disturbed as the heat collectors are secured in place. Any ecological impact will be minor and very localised.

During operation, the collector plates will take up space on the river bed and channel walls, but will not present any physical obstruction. The total area occupied is small at around 40 $m^2$ only, so any impact on habitats would be very limited.

The surface of the collector plates may be noticeably cooler than the river temperature, and as the collector fluid contains antifreeze it may be slightly below 0 C. This is not expected to have any adverse impact on ecology.

As mentioned in the Resource section, the river flow is more than sufficient to ensure that the river temperature does not reduce by more than 2 degrees, in line with EA guidance. Even during a Q99 flow of around 0.2 $m^3/s$, the maximum heat extraction rate of 225 kW would reduce the average river temperature by less than 0.3 degrees.

The thermal transfer fluid within the collector plates is typically non-toxic ethylene or propylene glycol. Both were recently confirmed as non-hazardous pollutants under the Water Framework Directive; they do not bioaccumulate, they biodegrade quickly and are non-toxic in aquatic environments. The impact of any leaks into the watercourse would therefore be very limited. Any leaks would be apparent due to the drop in water pressure within the circulation loop, allowing the problem to be fixed promptly.

**EA consents**

Closed-loop heat pump systems do not require an abstraction or impoundment licence from the Environment Agency. A flood risk activity permit (FRAP) will be required, which will permit both the temporary and permanent works in and near the river. Despite the name, this permit relates not only to flood risk but also environmental impacts. In particular, the permit will require a Water Framework Directive (WFD) assessment to be submitted, as well as a detailed method of work for construction. The permit typically takes around 3 months to be determined.

We expect the FRAP to be relatively straightforward to obtain as the impact on flood risk and the environment is extremely minor. The EA was contacted to confirm the relevant fee; the relevant activities are likely to fall under categories 1.1.2 and 1.1.3, with total fee £501.

A third-party ecological appraisal may be required as part of the EA consenting process.

**Planning permission**

Although the building is listed, due to the very minor impact on the listed structures it is likely that the project would be considered to be permitted development. The impact on the building itself would be limited to a small number of pipework entries. The visual impact as viewed from the adjacent footpath would be very minor: the collectors will be visible on the river bed but will be inconspicuous and will not affect the character of the building.

A response to our request for pre-application advice was received in October 2019. The project is deemed to not require full planning consent, however Listed Building Consent would be required.

**Renewable Heat Incentive (RHI)**

General requirements

Various documents are required in order to qualify for the non-domestic RHI scheme, including:

- Evidence that the installation is new
- Commissioning certificate & photos
- Metering (MID) certificate & photos
- Detailed schematic diagram
- Evidence of non-domestic status
- Heat pump manufacturer's specification & installer declaration to ensure SPF > 2.5
- Evidence that any public grants have been repaid
- External pipework heat loss calculations

Please note that whilst the domestic RHI requires loft or cavity wall installation if recommended on the EPC, the non-domestic RHI has no such requirements.

Degression

The RHI tariff rate may be degressed (reduced) based on forecast expenditure for each technology and for the RHI scheme as a whole. These are compared against the anticipated levels for expenditure, and for the rate of increase in expenditure, as published in advance.

- A degression of 10% was recently applied to large heat pumps (>=100kW), effective from 1 April 2020
- We expect a further 20% degression effective from 1 July 2020. There is a small chance this will be 25%
- We expect a further degression of 10% effective from 1 October 2020. There is a chance this may increase to 15%, 20% or 25%

The tariff rate assigned to the project will be the applicable rate at the time that a Stage 1 Tariff Guarantee application was made, subject to that application being approved successfully.

Deadline & tariff guarantees

The current official deadline for installation and commissioning of heat pump projects under the Non-Domestic RHI scheme is 31 March 2021. This is unlikely to be achievable.

During the 2020 budget it was announced that the government will create 'a new flexible allocation of Tariff Guarantees under the Non-domestic RHI, allowing plants to commission after 31 March 2021'. A public consultation was issued on 28 April 2020, which shows that the government intention is as follows:

- Installation & commissioning may take place after 31 March 2021 (until 31 March 2022), providing that 'stage 2' (financial close) information has been submitted by 31 March 2021

- However, no RHI payments will be made beyond 31 March 2041. This means that a system commissioned on 31 September 2021 would receive 19.5 years of RHI payments instead of 20 years

Please note that this follows the existing 'tariff guarantee' process:

*Stage 1 application:*

- Information requires includes:
    - Capacity of the system (kW) (must commission within 10% of this)
    - Evidence of planning permission & environmental permits
    - Expected commissioning date (cannot commission before this)
- At this stage the project will be checked against the Tariff Guarantee budget. If there is no budget available, the project will not progress and will be placed in a queue
- Upon approval, Ofgem will issue a Provisional Tariff Guarantee Notice (PTGN)

- No financial information needs to be submitted, but should be ready in preparation for Stage 2

*Stage 2 application:*

- Once Stage 1 has been approved, Stage 2 application must be submitted within 3 weeks
- Evidence that sufficient funds to cover all project costs have been committed to the project, with this evidence verified by an independent auditor
- Upon approval, Ofgem will issue a Tariff Guarantee (TG)

*Stage 3 application:*

- To be made upon commissioning

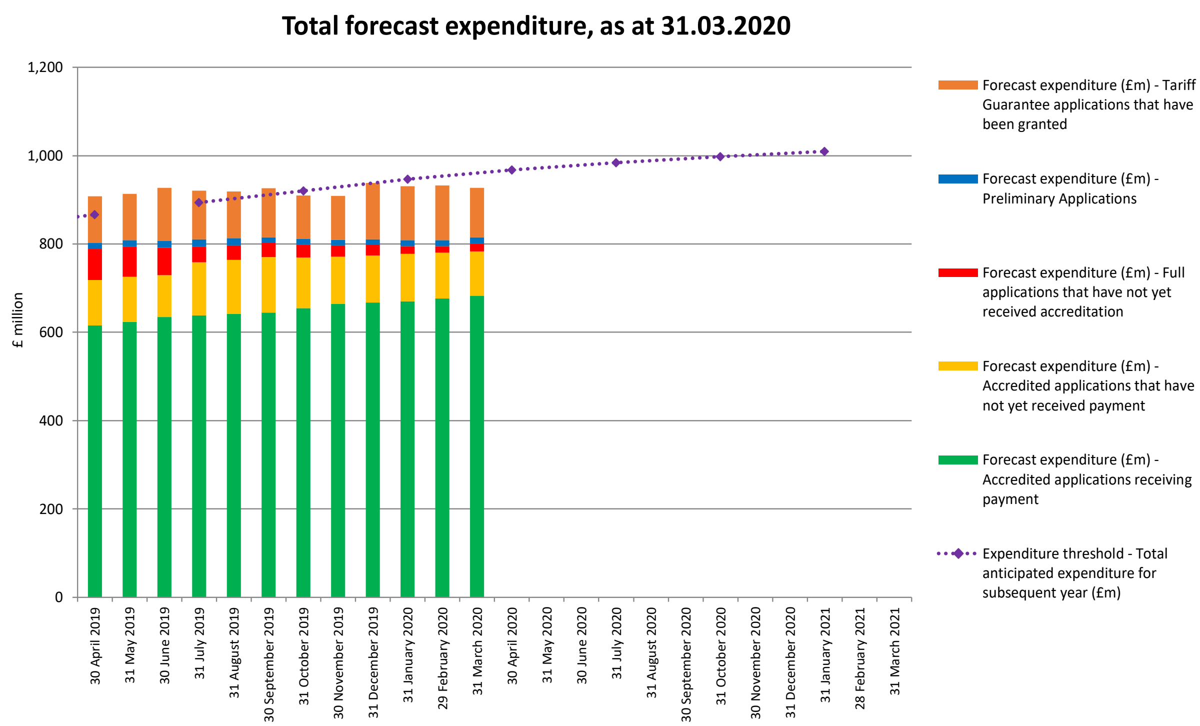
<u>Budget caps</u>

In addition to the overall deadline and tariff guarantee timescales, the RHI scheme includes budget caps on expenditure: one for the overall scheme and one for tariff guarantee applications. The budget caps and expenditure are assessed as a 12-month forecast, so they do not necessarily always increase.

If the overall scheme budget cap is reached, it is likely that the RHI will close entirely for all new applicants. This will be subject to parliamentary approval. The overall budget cap for 2020/21 is £1,150m.

If the TG budget cap is reached, no further TG applications will be accepted. This is written into RHI legislation. The legislation does allow BEIS to increase the TG budget cap; no increases have been made to date and it is unclear whether this would be done in future. The TG budget cap for 2020/21 is £150m.

The chart below shows the overall RHI expenditure (12-month forecast) at around £900m and the TG expenditure (orange) at around £110m. Both are relatively stable, however given the upcoming closure of the RHI scheme, we can assume that both are likely to increase, which means it is possible that one or both of the caps will be met.



Summary

The RHI rate was degressed by 10% in April 2020 and is expected to be reduced further. The project will be able to secure an RHI rate upon submission of a Stage 1 TG application. This requires that full consents are in place, so is expected to be during the Jul-Sep tariff period. We expect a further degression of 20% to take place, giving tariff rates for this project of 6.98 p/kWh (tier 1) and 2.08 p/kWh (tier 2).

There is a risk that the overall RHI budget will be met, which would mean that RHI support cannot be obtained.

There is a risk that the TG budget cap will be met, which would mean that further degressions would apply to the project, resulting in lower tariff rates. This would also increase exposure to the risk of the overall RHI budget being met.

If the project is commissioned after 31 March 2021, the overall period of RHI payments would be reduced accordingly. For example, if commissioned on 31 June 2021, the project would receive 19.75 years of RHI payments.

**Other certifications**

Microgeneration Certification Scheme (MCS) regulations do not apply here, as the installation will have a thermal output of more than 45 kW.

Other certification registrations will be required, such as Part P & G3, GasSafe and OFTEC for the electrical, hot water, gas and heating installation works respectively.

## Finances

**Budget cost**

| **Item** | **Unit price** | **Qty** | **Price** |
|---|---|---|---|
| 75 kW plant room heat pump | £17,237 | 3 | £51,711 |
| 15 kW Evo heat pump | £7,875 | 1 | £7,875 |
| 400L hot water cylinder | £1,460 | 1 | £1,460 |
| Collector pipe 40mm PE100 SDR11 HDPE, 100m | £237 | 3 | £711 |
| Other fittings (reducers, elbows, etc) | £485 | 1 | £485 |
| Subterranean manifold | £1,365 | 1 | £1,365 |
| Anti-freeze drums, 25L | £97 | 30 | £2,910 |
| Circulation pumps | £2,000 | 3 | £6,000 |
| Header pipe 110mm MDPE, 50m length | £405 | 1 | £405 |
| 1000L two-connection buffer tank | £2,850 | 1 | £2,850 |
| Flat plate heat collectors with mounting frame | £1,220 | 38 | £46,360 |
| Heat & power metering | £1,960 | 1 | £1,960 |
| Low-temperature emitters | £750 | 100 | £75,000 |
| Detailed design & consenting | £25,000 | 1 | £25,000 |
| Installation & commissioning | £28,000 | 1 | £28,000 |
| RHI application | £950 | 1 | £950 |
| | | | |
| *Contingency* | | *15%* | *£37,956* |
| **TOTAL** | | | **£290,998** |

The heat pump and emitter parts of this costing are based on quotes received from Kensa and Jaga, partly previous quotes for this project and more recent quotes for another project we are working on. The price for collector plates is a budget estimate at this stage.

This cost estimate does not take into account the benefits associated with not needing to relocate the existing boilers and gas supply, or replace the boilers at the end of their lifetime. The heat pump has an expected lifetime of 20-25 years.

The costs above do not include any distribution-side works, such as works to relocate the plant room.

**RHI payments**

The expected non-domestic RHI rate, as discussed in the previous section, is 6.98 p/kWh within tier 1 and 2.08 p/kWh within tier 2. The tier 1 rate is paid for all heat delivered up to an equivalent of 1,314 hours per year at peak output (15% capacity factor). The tier 2 rate is paid for heat beyond this. Payments are CPI-linked and guaranteed for 20 years.

Both space heating and hot water production are eligible for RHI payments, so the total eligible amount is estimated as 248,600 kWh. The overall system, totalling 245 kW installed capacity, has an estimated capacity factor of 11%. The installation will therefore make full use of the higher RHI rate.

Please note the comments on RHI deadlines in the previous section.

**Running costs**
Gas supply is currently via Total Gas & Power with a unit price of 4.402 p/kWh. The climate change levy (CCL) applies at the 2019 rate 0.339 p/kWh. Based on the reduced demand of 248,600 kWh, gas heating would cost around £11,780 per year.

The current cost for electricity is around 11.3 p/kWh. The climate change levy (CCL) applies at the 2019 rate 0.847 p/kWh. Based on a seasonal performance factor (SPF) of 3.5, the electrical demand for a heat pump system would be 71,000 kWh at a cost of around £8,630 per year.

The heat pumps do not require any more maintenance than the existing gas boilers require, so no additional allowance has been made for this. However, a small sum of £450 per year has been estimated for performance monitoring and any minor maintenance of the collector plates.

The effective income by comparison of gas and electricity costs would therefore be £2,700 per year. In addition to this, the project would receive RHI payments of approximately £17,350 per year, giving an overall effective income of around £20,050.

**Financial return**
The initial outlay of £290,998 is offset against an effective income of £20,050. The resulting payback period is 14.5 years with a 20-year project IRR of 3.3%.

**Carbon footprint**
The current government conversion factors for greenhouse gas reporting are:

- Natural gas 0.1839 kg CO2e / kWh (gross CV)
- Electricity 0.2556 kg CO2e / kWh

Based on the reduced heating demand, the carbon footprint is estimated as 45,750 kg CO2e. By switching from gas to heat pumps this would reduce to 18,160 kg, a reduction of 60%. Alternatively, a 100% renewable tariff could be used (at additional cost) to eliminate the carbon footprint entirely.

**Other benefits**
In addition to the financial and environmental benefits of switching to a heat pump system, the heat pump system will also allow a certain extent of cooling, with minimal operational costs, by running the circulation pumps only.

## Summary & next steps

**Key findings**

The building is currently heated to 25C, which with a typical occupancy of 60 results in a peak space heating demand of 240 kW. By reducing the internal temperature to 21C, the peak space heating demand is expected to reduce to 204 kW. In addition to the space heating demand is a hot water demand of up to 20 kW. This brings the total predicted peak heating demand to 224 kW.

The site is suitable for a water-source heat pump installation and is not constrained by the available heat resource in the river. Steel flat place collectors would be situated in the river, with pipework running to a new plant room location on the ground floor of the main mill building.

Any heat pump installation would require replacement of the radiators with low-temperature models, allowing a flow temperature of around 45C. This will be more cost-effective than using a higher flow temperature.

We recommend installation of a main heat pump system rated at 225 kW heat pump system, which would meet 100% of the space heating demand at the site. A further 15-20 kW heat pump is recommended for provision of hot water. This would operate using the same heat collector.

The total project cost is estimated as £290,998 + VAT with a predicted payback period of 14.5 years and 20-year project IRR of 3.3%. A $CO_2e$ saving of 60-100% of the building's heating (27-46 tonnes per year), which would be a significant contribution to reducing the council's carbon footprint. The project would also pave the way for further similar installations at other historic buildings within the Stroud area.

If the council wishes to carry out this installation, it is critical that the project should be developed quickly in order to secure the highest possible RHI rate. To minimise the effects of RHI degression, consents for the project would need to be obtained during the Jul-Sep tariff period.

**Next steps**

The following step would be to begin the detailed design & consenting. We understand that this is likely to form part of a design & build contract.

The project timeline is expected to be as follows:

| | |
|---|---|
| **Jun 2020** | Detailed design & consent applications |
| **Sep 2020** | Consents granted |
| **Sep 2020** | Stage 1 Ofgem application |
| **1 Oct 2020** | *RHI degression (if Stage 1 Ofgem application not submitted)* |
| **Oct 2020** | Stage 2 Ofgem application* |
| **Nov 2020** | Completion of remaining design work |
| **Dec 2021** | Place order for main components |
| **May 2021** | Installation & commissioning |
| **May 2021** | Stage 3 Ofgem application |

**please note that arrangements for project financing need to be finalised by this point.*

We feel this report demonstrates that the project will provide significant environmental benefits whilst being technically and financially feasible. We hope to work with you to deliver the remaining stages of this project.

Hydro, Wind & Heat Pump Consultancy, Design & Installation

# Ebley Mill

## Water-source heat pump feasibility study

| Ref: | Issue: | Date: | Lead author: | Approved by: |
|---|---|---|---|---|
| EBLEY_HPFS | 01<br>02<br>03 | 25-03-19<br>29-04-20<br>06-05-20 | WH<br>WH | Philip Davis – Managing Director |

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# Contents

# Introduction

**Executive summary**

This report summarises the feasibility of a water-source heat pump installation at Ebley Mill, which houses the main offices of Stroud District Council. The council is exploring options to decarbonise the heating of this building, in line with its aim to make the district carbon neutral by 2030.

Our assessment reviews the available resource, heating demand and existing emitters, before recommending an outline system specification and next steps to progress the project.

Overall, the project would enable a CO2e reduction of 60-100% (70-110 tonnes per year). The project would not quite recover its installation costs within its lifetime, unless the capital cost can be reduced. In order to avoid further RHI rate reductions, the project would need to progress very quickly to obtain the necessary consents during the Jul-Sep tariff period.

**Heat pump technology**

Heat naturally flows from hot to cold. A heat pump is a device that moves heat in the opposite direction: it pumps heat from a cooler 'source' to a warmer 'sink'.

Domestic fridges use this principle to transfer heat from the interior into the surrounding room. In a similar way, it is possible to transfer heat from the external environment into a building's heating system.

The most common type of heat pump is an electrical compression heat pump. The heat pump works by allowing a refrigerant to absorb heat, which causes it to evaporate, then using electricity to compress the refrigerant, which causes it to condense and release its heat. This allows heat to be moved, by absorbing it from one location and releasing it in another.

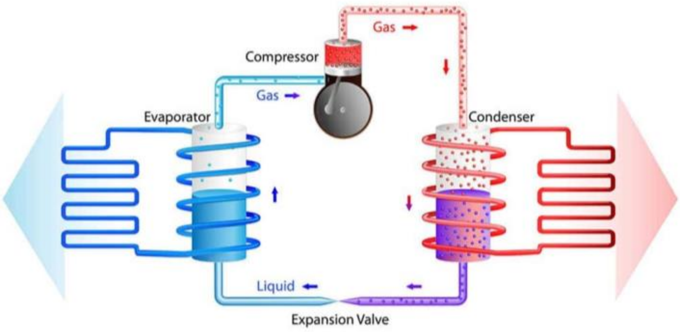



Figure 1 – Heat pump operation

All heat pumps operate most efficiently when the source and sink temperatures are similar. This is characterised by the coefficient of performance (COP), which is the ratio of heat power output and electrical power input.

Rivers, lakes, and other bodies of water are heated by the sun and so provide a source of renewable heat that can be used in homes and businesses. Water has a high heat capacity and a relatively stable temperature throughout the year, which results in water-source heat pumps typically having a much higher COP than air- or ground-source heat pumps.

Most water-source heat pump systems use a 'closed loop' to circulate a thermal transfer fluid (antifreeze mixture) between the heat pump and the water. Inside the heat pump, heat exchangers transfer heat to the refrigerant and then on to the building heating system.

‘Open-loop’ systems that abstract water are possible, however water quality issues mean an intermediate heat exchanger is required, with higher maintenance requirements. These systems are generally better suited to large scale applications.

# Resource

**Watercourse flow**
The Frome has been gauged at Ebley by the Environment Agency since 1969. Figure 2 shows the flow duration curve based on the most recent 20 years.

The mean flow is 2.81 $m^3/s$ with a 'Q95' flow of 0.89 $m^3/s$. This means that the flow in the river at this point will be above 0.89 $m^3/s$ for 95% of the time. In practice, flows below this level will always occur during summer.

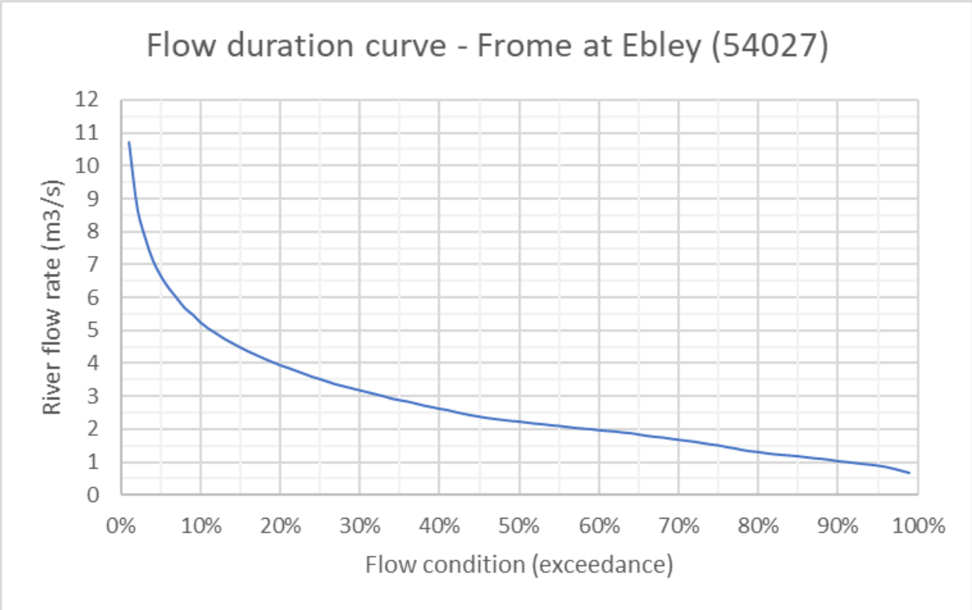



Figure 2 – Flow duration curve

Environment Agency guidance stipulates a maximum drop in river temperature of 2 degrees. Extracting 2 degrees from the Q95 flow of 0.89 $m^3/s$ would yield around 7 MW. It is therefore very unlikely that low river flow will limit heat power here.

**Climate & river temperature**
Air and river temperature data were obtained as follows. The findings are shown in Figure 3.

| Parameter | Data type | Source | Period | Location |
|---|---|---|---|---|
| Air temperature | Daily min/mean/max | Met Office | 1981-2010 | Cirencester |
| River temperature | Spot measurements | EA 'WIMS' | 2000-2015 | Ebley |

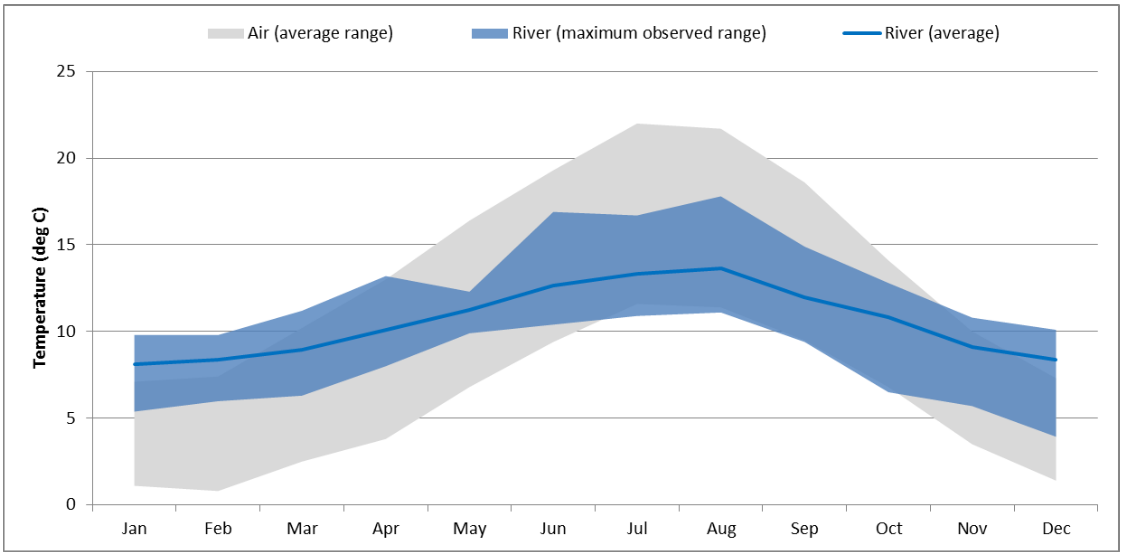


Figure 3 – Local temperature data

The lowest river temperatures recorded are:

| Date / time | River temperature (°C) |
|---|---|
| 03/12/2010 14:50 | 3.93 |
| 11/12/2008 08:45 | 5.00 |
| 09/01/2009 14:20 | 5.38 |

In summary, the local temperature data show that river temperature typically falls to around 7°C during Dec-Jan and occasionally below 4°C.

During periods when the river temperature is low, the heat pump will continue to work effectively, however the efficiency will be reduced. Details of the system performance are given later in this report.

As the river is relatively fast-flowing, it will be well-mixed with no significant variation in water temperature across the site.

# Building details

**Construction**
Ebley Mill is a former wool mill that was converted for offices in 1990. It is of limestone construction with Welsh slate roof tiles and large arched windows. Historically, the mill was powered by up to five waterwheels, and later with steam power.

The building has three main sections:

| | |
|---|---|
| **Bodley Block** | The north end of the building. Five floors, with an additional area on the ground floor |
| **Long Block** | The central section, with five floors |
| **New Block** | The south end of the building, with two floors. Newer construction |

**Total floor area**: 5,313 $m^2$
**Total volume**: 19,991 $m^3$

In general, the walls are solid stone construction around 450 mm thick and include large single-glazed windows with small panes and metal frames. The windows are double glazed throughout New Block and on one floor of Long Block. Elsewhere the vast majority of windows are fitted with secondary glazing. The building is assumed to have a suspended floor throughout and has a pitched tiled slate roof, with dormer windows throughout Long Block. The roof is insulated with 2L2 foil bubble insulation.

An EPC assessment was carried out in 2019 and returned a D rating.

**Heating system**
The main plant room is on the ground floor of Bodley Block, which houses three gas boilers (installed 1987) that supply Bodley Block and Long Block. New Block has its own heating circuit using two newer gas boilers located in a plant room on the ground floor.

*Existing heating equipment:*

| ***Equipment*** | ***Specification*** | ***Notes*** |
|---|---|---|
| ***Gas boilers*** | *3 x 235 kW Hoval SR800 boilers (gas)*<br>*2 x 120 kW Concord CXA/H boilers (gas)*<br>*[exact model unclear but 120kW assumed]* | Flow 80°C (when external -1°C)<br>Flow 80°C (assumed) |
| **Hot water heaters** | Point-of-use electrical heaters only | We do not propose any changes to the hot water system |
| **Emitters** | Traditional high-temperature radiators<br>All radiators fitted with TRVs<br>Council chamber has four larger wall-mounted convector heaters | |
| **Control system** | Internal and external temperature sensors<br>Weather compensation | Heating on 06:00-15:30 Mon-Thu, 06:00-15:00 Fri, off Sat/Sun<br>Some zoning, but possibly faulty |
| **Air-conditioning** | A Daikin air conditioning unit serves the council chamber only. Small additional units also operate in the server room. | There is also a ducted air cooling system which is no longer used. |

**Heat demand**

Occupancy

The building is fully occupied with the exception small areas undergoing refurbishment. During 2019 the building was fully occupied with the exception of a three-month period when Long Block was refurbished, one floor at a time (each taking one month).

Hot water demand

Hot water demand is not included in this assessment due to the use of electrical heaters at point of use.

Space heating overview

Space heating can be broken down as:

*Emitter heat power + casual heat gain rate + solar heat gain rate = Fabric heat loss rate + ventilation heat loss rate*

Casual heat gain rate:

| Item | Unit heat gain rate ($W/m^2$) | Area ($m^2$) | Total heat gain rate (kW) |
|---|---|---|---|
| Lighting in use | 12 | 6367 | 76.4 |
| Equipment | 14 | 6367 | 89.1 |
| Occupants | 6 | 6367 | 38.2 |
| **TOTAL** | | | **203.7** |

Solar heat gain rate (winter average):

| Aspect | Area ($m^2$) | Unit heat gain rate ($W/m^2$) | Total heat gain rate (kW) |
|---|---|---|---|
| NE/NW-facing | 435 | 39 | 17.0 |
| SE/SW-facing | 546 | 60 | 32.8 |
| **TOTAL** | | | **49.8** |

Fabric heat loss rate:

| Element | Description | U-value (W/m²K) | Area (m²) | | | | Heat loss rate (W/K) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | *New* | *Long* | *Bodley* | *Total* | *New* | *Long* | *Bodley* | *Total* |
| Walls | 450mm limestone, uninsulated | 2.23 | 751 | 1797 | 804 | 3352 | 1674 | 4007 | 1794 | 7474 |
| Windows / glazed doors | Double glazed | 2.80 | 149 | 83 | 0 | 232 | 416 | 233 | 0 | 649 |
| Windows | Single pane, metal frames, with secondary glazing | 2.70 | 0 | 333 | 351 | 684 | 0 | 900 | 948 | 1847 |
| Skylights | Single pane, wooden frames | 4.80 | 0 | 0 | 66 | 66 | 0 | 0 | 315 | 315 |
| Doors | Solid wood | 3.00 | 28 | 14 | 9 | 51 | 84 | 43 | 26 | 153 |
| Wood panelling | Solid wood | 3.00 | 18 | 0 | 0 | 18 | 55 | 0 | 0 | 55 |
| Roof | Slate tiles with 2L2 insulation (R=1.5) | 0.67 | 893 | 734 | 625 | 2251 | 595 | 489 | 416 | 1501 |
| Floor - NB | Suspended timber, uninsulated | 0.30 | 783 | 0 | 0 | 783 | 233 | 0 | 0 | 233 |
| Floor - LB | Suspended timber, uninsulated | 0.36 | 0 | 581 | 0 | 581 | 0 | 208 | 0 | 208 |
| Floor - BB | Suspended timber, uninsulated | 0.29 | 0 | 0 | 602 | 602 | 0 | 0 | 176 | 176 |
| | | | | | | | | | | |
| **TOTALS** | | | | | | | **3057** | **5880** | **3675** | **12613** |

Please note the figures above do not include losses due to thermal bridging or ground conduction.

Ventilation heat loss rate & overall demand:
The ventilation heat loss rate depends on the number of air changer per hour (ACH), which can only be directly measured using infiltration testing. To estimate the ACH value, the fabric heat loss rate was compared with existing overall consumption based on gas bills.

Hourly temperature data during 2019 was obtained for the weather station at Gloucestershire Airport, which should have a similar temperature profile to Ebley Mill. This was used to establish the temperature differential between the internal and external temperatures.

Taking into account the heating profile, which is typically 06:00-15:30 weekdays, the overall demand was modelled on an hourly basis. These results were summed for the periods shown on the gas bills for comparison and determination of the ventilation rate.

The gas consumption as stated on the bills was adjusted by a factor of 83% to provide the actual heat delivered. This accounts for the estimated efficiency of the heating system.

Please also note:

- A gas-to-heat efficiency of 83% was assumed
- The heating demand use for comparison with bills was reduced to account for the council chamber being heated by a separate system (electric convectors)
- Year-to-year variation in heat demand has not been estimated
- Solar gains are modelled as constant throughout the year, therefore the model will slightly over-estimate heat demand in summer and slightly under-estimate in winter
- Each floor of Long Block was unheated for a period of up to one month per floor during renovation in 2019. This may have reduced gas consumption by 8-10% during that period. However, it is not known exactly when this was carried out, so no adjustment has been made.
- The effects of thermal mass and warm-up / cool-down periods have not been assessed
- This analysis assumes that ACH is constant, whereas in reality it will vary according to factors such as wind speed/direction, occupant behaviour and internal/external temperature

The model gives the closest fit with gas bills data when ACH is set to 4.75, with results as shown in Figure 4.

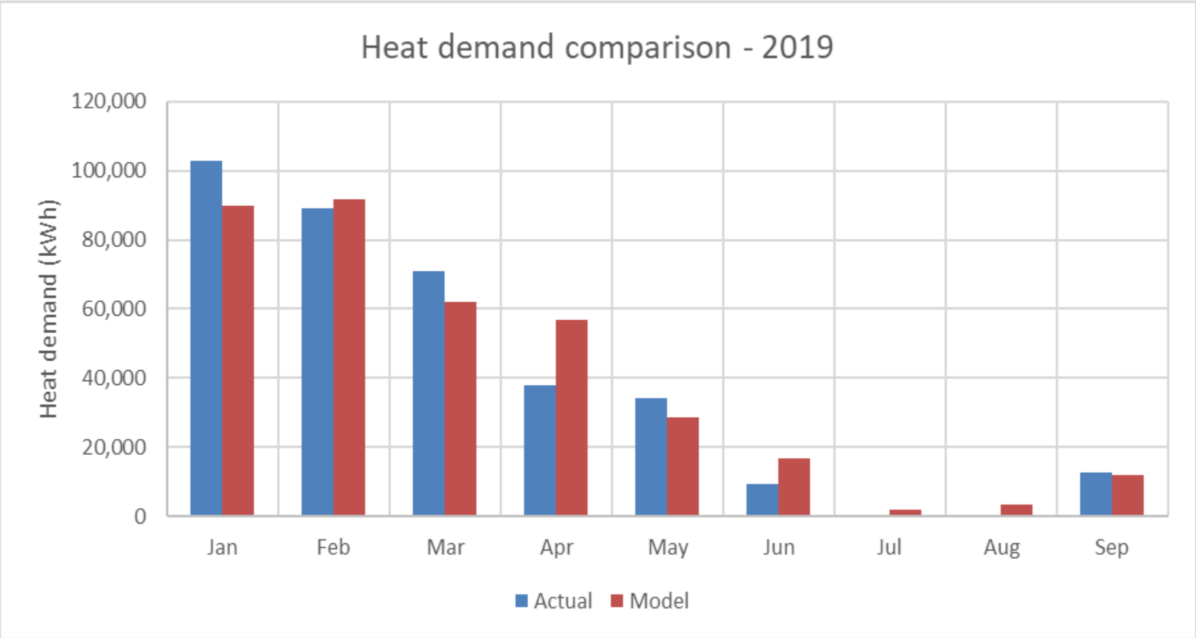



Figure 4 – Monthly heat demand comparison (Months approximate based on bill periods)

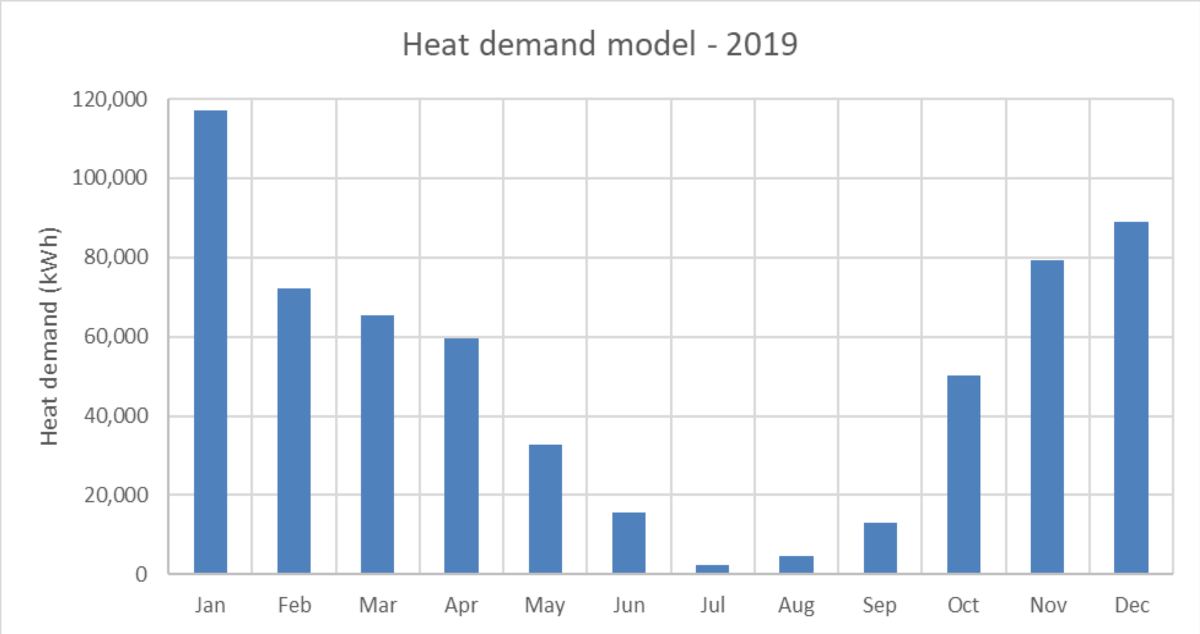



Figure 5 – Modelled heat demand profile (Months exact)

The predicted overall section-by-section heat loss rates are as shown below:

| **Section** | **Fabric (kW/K)** | **Ventilation (kW/K)** | **Total (kW/K)** | **Peak heat loss [dT=25K] (kW)** |
|---|---|---|---|---|
| New Block | 2.96 | 6.61 | 9.57 | 239 |
| Long Block | 5.87 | 14.24 | 20.11 | 503 |
| Bodley Block | 3.75 | 10.78 | 14.53 | 363 |
| **TOTAL:** | **12.59** | **31.62** | **44.21** | **1105** |

The overall peak space heating demand, ignoring gains, is 1105 kW. This is based on an internal temperature of 21C and external temperature -4C. Accounting for gains, the peak heat demand is approximately **850 kW**. This is relatively similar to the capacity of the existing boilers, which is 945 kW.

Please note that the secondary glazing is likely to have reduced the heating demand by around 10%, so before this was installed the peak heat demand (after gains) would have been approximately 900 kW.

The rating of the existing boilers will have been determined based on not only the peak heat losses but also the desired warm-up time for the building. Any heat pump installation would also need to ensure the warm-up times are acceptable.

The peak heat demand per unit floor area, based on the result above, is 208 W/m$^2$ before gains and 160 W/m$^2$ after gains.

The annual heating demand of the property including the council chamber, based on analysis from 2019, is approximately **600,770 kWh**.

**Emitters**
Within Long Block, typical emitter provision is one radiator per window, with a shorter radiator at the front (NW side) and a longer radiator at the rear (SE side). The heat output of these radiators is estimated as:

| Position | Type | Dimensions (cm) | Flow/return/internal temperature (C) | Estimated heat output (W) |
|---|---|---|---|---|
| Front window | 2p1c | 85 x 40 (x 5.5) | 80/60/20 | 849 |
| Rear window | 2p1c | 128 x 40 (x 5.5) | 80/60/20 | 1278 |
| **Total** | | | | **2127** |

The floor area served by these radiators is approximately 33 $m^2$, giving a heat output of approximately 64 $W/m^2$. This will be increased when the building is warming up, for instance if the internal temperature is 15°C the expected output would increase by a factor of 1.13.

Nevertheless, this is significantly below the required peak heat demand estimated above, which suggests that the peak demand for the building may be lower than 850 kW. To resolve this difference, a more accurate model of heat demand may be required, in particular to account for intermittent heating.

**Testing**
A simple test of the heating will be carried out to provide valuable data on both the overall building heat loss. The test will involve monitoring gas consumption and external temperature over a period of several hours, while the internal temperature is stable. This will allow an estimate of the building heat loss (kW/K) that is more accurate than the methods used so far, as it provides higher resolution gas data and uses actual external temperature data from the site, instead of data from a nearby weather station. This test will require monitoring of internal temperatures or ensuring that the temperature control settings (including for TRVs) are known.

The above test will be carried out by Renewables First with results added as an appendix to this report.

Another useful test would be monitoring the gas consumption first thing on a Monday morning, to estimate the maximum heat output of the radiators. Alternatively, this test could be done by reviewing half-hourly gas consumption data (if available). This test would require all radiators to be turned on throughout the property.

**Energy efficiency improvements**
Any energy efficiency improvements will be valuable not only by reducing heating requirements but also by allowing lower flow temperatures to be used, which will improve heat pump efficiency.

As part of this assessment it has been assumed that the internal temperature is 22°C and this will be maintained. Please note that reducing the internal temperature by just 1 degree to 21°C would reduce heating demand by around 13%.

We estimate that around 70% of heat losses in the building are via ventilation, so draughtproofing is recommended. A reduction in air change rate of 25% would reduce energy usage by around 30%.

A thermal imaging survey could be carried out to identify key areas for draughtproofing, which would also identify areas where additional insulation would be most effective. This can be carried out at a relatively low cost.

No changes in internal temperature or improvements to airtightness or insulation have been assumed as part of this assessment.

## System design

**Emitters**

Although heat pumps are capable of delivering high flow temperatures, it is generally more cost-effective to use a lower flow temperature and replace the radiators with low-temperature models. The RHI also places restrictions on the minimum system efficiency to qualify, which would not be met using the existing flow temperature of 80°C.

Using the existing radiators with a flow temperature of 50°C instead of 80°C would reduce their output by approximately 60%. It will therefore be essential that the radiators are replaced with low surface temperature (LST) fan-assisted radiators, which have a much greater heat output.

Replacing the 128x40 radiators Long Block with LST radiators of a similar size would allow use of flow/return temperatures of approximately 50/40°C. This would therefore enable a relatively high heat pump efficiency whilst minimising disruption.

Please note that the replacement radiators require a power supply, so some electrical works are required throughout the building. In some cases, it may be possible to upgrade the radiators by increasing the number of panels and/or convectors, instead of installing fan-assisted models.

**Heat pump sizing**

The heat pump size affects various factors including efficiency, carbon savings, RHI payments and practicalities. A smaller system would be less expensive but would require bivalent operation (alongside retained gas boilers) whereas a larger system could provide the entire heating load (a 'monovalent' system).

Consideration of bivalent system

The main attraction of using a bivalent system is to avoid the need to replace the existing radiators, by using the heat pump to provide low-level heat only, with the retained gas boilers taking over when it becomes cost-effective to do so. This point (known as the 'bivalent point') will in practice be the point at which the system COP drops below 2.9, which is the required standard for RHI.

This is expected to correspond to a maximum flow temperature of 60°C, at which point the heat output from the radiators would be around 55% of their existing output. Annually, we would expect the heat pump system to provide 50-60% of the space heating requirements.

As the reduction in heat output is similar to the reduction in heat pump rating, the project payback would be relatively similar. The key differences would be the reduced capital cost and reduced carbon saving. In the interests of meeting CO2 reduction targets as quickly as possible, we therefore do not recommend using a bivalent system in this case.

Another consideration is that the lifetime of the heat pump system is expect to be at least 20-25 years, so it is likely to extend beyond the RHI period. After the RHI ends, the COP required for the heat pump to be cost-effective would increase, requiring a lower flow temperature. At this point it may be decided to upgrade radiators and increase the heat pump capacity. Installing a monovalent system now will ensure that it continues to work effectively beyond the RHI period.

Recommendation

We recommend heating the building entirely using a heat pump system for the following reasons:

- To ensure the maximum possible carbon reduction
- To maximise the heating system efficiency
- To avoid over-complication of the heating system
- To maximise financial benefits by making use of the high RHI tariff for heat pumps
- To ensure that the heat pump system continues to be cost-effective after the RHI ends

**Plant room**
Either of the existing boiler rooms could potentially be used for the heat pumps, however there is more space available in the Bodley Block boiler room.

The new plant room area is therefore expected to be located in the existing main plant room in Bodley Block. Each of the four proposed heat pumps will have a footprint of approximately 2000 x 900 (x1650h) mm, which is similar in scale to the existing gas boilers.

Ideally the New Block heating circuit would be connected to the Bodley/Long Block circuit, so that the heat pump system works entirely from the plant room in Bodley Block. Alternatively, a separate heat pump system with separate collector circuit could be installed in the New Block boiler room.

**Collector type**
At this site both open-loop and closed-loop systems could be considered.

An open-loop system would require some in-river works to create the abstraction and discharge points. The abstraction flow rate required to meet the 850 kW demand, based on reducing the temperature by 3 degrees, is 68 litres per second. This would require an intake structure approximately 10 m wide incorporating four Rotorflush pumps, which could be located along the bank of either the canal or the main river. A single discharge pipe would then discharge into the river. This is likely to discharge below the water surface, after passing through an underground silt trap chamber.

The abstracted water would be hydraulically separated from the heat pump by use of an intermediate plate heat exchanger located in the plant room. The maintenance requirement of the abstraction pumps, heat exchanger and outfall structure adds an operational cost when compared to a closed-loop system.

A closed-loop system would require some in-river works to mount stainless steel heat exchange plates to the channel. The canal walls provide a convenient surface but, due to the very low flow rate in this section, either a large number of panels or a pumped system to increase flow over the panels would be required. The preferred location is in the main river, with panels mounted onto the natural river bed. It should be relatively easy to fix the panels in place using ground anchors, provided this is done in summer during low river flows.

A kay advantage of a closed-loop system is the reduced maintenance requirements. In addition, there would be no requirement for an abstraction licence, which can take several months to obtain.

We would not recommend the use of pond mats or ‘energy blade’ type collectors at this site, as these are susceptible to damage and blockages from river debris.

Flat heat exchange panels can extract around 6 kW per m$^2$, based on a flow speed of 0.25 m/s passing over the panel. During June 2019 when the river depth was surveyed, the average depth was around 50cm giving a total channel cross-section area of around 5 m$^2$. Based on a Q95 flow of 0.83 m$^3$/s the average flow speed would be 0.17 m/s. We have therefore assumed that a minimum of 4 kW could be extracted per m$^2$ of heat exchange panel. For a heat demand of 850 kW, the required panel area would be approximately 140 m$^2$. An example layout is shown in Figure 6.

The overall collector loop flow rate would be approximately 50 litres/second. The flow rate through each collector plate should be around 1 litre/second; the plates would be arranged into 50 groups accordingly. Within each group the collectors would be connected in series, whilst overall the groups would be connected in parallel. The collectors will be mounted on a steel frame and secured using ground anchors, as shown in Figure 7.

Overall, we recommend using a closed-loop system as this will minimise operation & maintenance requirements, while also being more straightforward to install and consent.


Figure 6 – Suggested collector layout

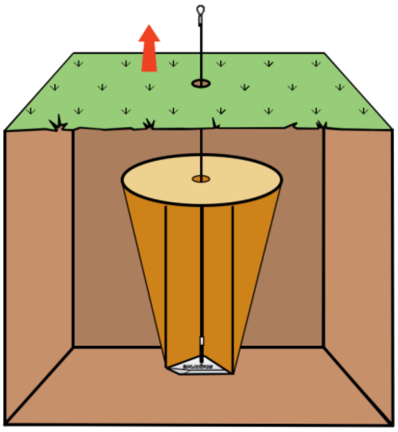


Figure 7 – Ground anchor diagram

**Collector pipework**
Pipework would pass from the collectors into an underground manifold chamber on the bank. From here, larger diameter flow/return pipes would carry the glycol mixture to the plant room.

Suggested pipe diameters and pressure loss calculations are as shown below. The power required for circulation pumping is discussed later in this report.

| **Element** | **Flow rate** | **Pipe OD** | **Flow speed** | **Length** | **Pressure drop** |
|---|---|---|---|---|---|
| | l/min | mm | m/s | m | mH2O |
| Collectors | 60 | - | - | - | 2.04 |
| Pipes to manifold | 60 | 40 | 1.2 | 20 | 2.60 |
| Manifold to plant room | 3000 | 225 | 1.9 | 50 | 1.35 |
| Additional bends/fittings | | | | | 2.00 |
| **Total pumped head** | | | | | **7.99** |

**Grid connection**
The maximum import capacity of the grid connection is currently unknown. The heat pump will require an import capacity of at least one-third of the rated heat power output. In this case the expected maximum import power is 290 kW. A load survey and application to WPD will be required as part of the project.

**Metering**
The heat pump system will include a MID-approved heat meter, which is a requirement for claiming RHI payments.

**Control system**
A dedicated heat pump control system will be provided by the heat pump manufacturer. This will include a weather compensation function, adjusting the flow temperature accordingly.

A separate building management system will be required to control zoning. We recommend a separate review of temperature sensors and motorised valves used for zoning.

**Predicted performance**
The performance of the heat pump system is shown below, based on 4no. Viessman Vitocal 300-G RedAstrum units with a total rated capacity of 850 kW. This does not include auxiliary power requirements such as circulation pumping.

| **Source inlet temperature (C)** | 5 | | 10 | |
|---|---|---|---|---|
| **Heating outlet temperature (C)** | 45 | 55 | 45 | 55 |
| **COP (heating)** | 4.21 | 3.38 | 4.71 | 3.82 |

Based on the expected flow temperature of 50°C and river temperature 8°C, the expected COP is approximately 4.08. The COP will be significantly above the minimum required for RHI, which is 2.9.

The circulation pumping requirement, based on the pressure drop stated above, is estimated as 8.2 kW. This will apply whenever the heat pump is operating. The proportion of time that the heat pump and circulation pump are operational can be approximated to the capacity factor, which for the overall system is 8%. This equates to 5,770 kWh for circulation pumping. The total heat delivered is around 600,770 kWh, so if this is done at a COP of 4.08 the electricity used for the heat pumps is 147,248 kWh. Adding circulation pumping increases the electricity usage to 153,019 kWh, bringing the overall COP to 3.93.

This COP is defined at a flow temperature of 50°C and river temperature 8°C. In practice, the conditions will often be better than this, as weather compensation control will reduce the flow temperature.

This overall performance of the heat pump across the year, taking into account circulation pumping and variations in temperature, typically referred to as the seasonal performance factor (SPF). Overall, the SPF for this site is estimated as 4.08.

There will be some additional auxiliary loads that will reduce the SPF a little further, however these are minor so have not been assessed here.

# Environment & consenting

**Environmental impacts**
During installation, the river bed may be slightly disturbed as the heat collectors are secured in place. Any ecological impact will be minor and very localised.

During operation, the collector plates will take up space on the river bed, but will not present any physical obstruction. The total area occupied is relatively small and being situated upstream of the weir minimises any impact on fish habitats.

The surface of the collector plates may be noticeably cooler than the river temperature, and as the collector fluid contains antifreeze it may be slightly below 0°C. This is not expected to have any adverse impact on ecology.

As mentioned in the Resource section, the river flow is more than sufficient to ensure that the river temperature does not reduce by more than 2 degrees, in line with EA guidance. Even during a Q95 flow of around 0.83 $m^3/s$, the maximum heat extraction rate of 648 kW would reduce the average river temperature by less than 0.2 degrees.

The thermal transfer fluid within the collector plates is typically non-toxic ethylene or propylene glycol. Both are classified as non-hazardous pollutants under the Water Framework Directive; they do not bioaccumulate, they biodegrade quickly and are non-toxic in aquatic environments. The impact of any leaks into the watercourse would therefore be very limited. Any leaks would be apparent due to the drop in water pressure within the circulation loop, allowing the problem to be fixed promptly.

**EA consents**
Closed-loop heat pump systems do not require an abstraction or impoundment licence from the Environment Agency. A flood risk activity permit (FRAP) will be required, which will permit both the temporary and permanent works in and near the river. Despite the name, this permit relates not only to flood risk but also environmental impacts. In particular, the permit will require a Water Framework Directive (WFD) assessment to be submitted, as well as a detailed method of work for construction. The permit typically takes around 3 months to be determined.

We expect the FRAP to be relatively straightforward to obtain as the impact on flood risk and the environment is extremely minor. The relevant activities are likely to fall under categories 1.1.2 and 1.1.3, with total fee £501.

If an open-loop scheme is progressed, this will require an Environment Agency abstraction licence, as well as a FRAP for any works in or near the river and Land Drainage Consent for any works in or near the canal.

A third-party ecological appraisal may be required as part of the EA consenting process.

**Planning permission**
Full planning permission is not expected to be necessary, however listed building consent is expected to be required as the building is Grade II* listed. This would be partly due to minor visual impact of the heat collectors as well as slight changes to the building structure to accommodate new pipework. The determination period for listed building consent is eight weeks.

**Renewable Heat Incentive (RHI)**

General requirements

Various documents are required in order to qualify for the non-domestic RHI scheme, including:

- Evidence that the installation is new
- Commissioning certificate & photos
- Metering (MID) certificate & photos
- Detailed schematic diagram
- Evidence of non-domestic status
- Heat pump manufacturer's specification & installer declaration to ensure SPF > 2.5
- Evidence that any public grants have been repaid
- External pipework heat loss calculations

Please note that whilst the domestic RHI requires loft or cavity wall installation if recommended on the EPC, the non-domestic RHI has no such requirements.

Degression

The RHI tariff rate may be degressed (reduced) based on forecast expenditure for each technology and for the RHI scheme as a whole. These are compared against the anticipated levels for expenditure, and for the rate of increase in expenditure, as published in advance.

- A degression of 10% was recently applied to large heat pumps (>=100kW), effective from 1 April 2020
- We expect a further 20% degression effective from 1 July 2020. There is a small chance this will be 25%
- We expect a further degression of 10% effective from 1 October 2020. There is a chance this may increase to 15%, 20% or 25%

The tariff rate assigned to the project will be the applicable rate at the time that a Stage 1 Tariff Guarantee application was made, subject to that application being approved successfully.

Deadline & tariff guarantees

The current official deadline for installation and commissioning of heat pump projects under the Non-Domestic RHI scheme is 31 March 2021. This is unlikely to be achievable.

During the 2020 budget it was announced that the government will create 'a new flexible allocation of Tariff Guarantees under the Non-domestic RHI, allowing plants to commission after 31 March 2021'. A public consultation was issued on 28 April 2020, which shows that the government intention is as follows:

- Installation & commissioning may take place after 31 March 2021 (until 31 March 2022), providing that 'stage 2' (financial close) information has been submitted by 31 March 2021

- However, no RHI payments will be made beyond 31 March 2041. This means that a system commissioned on 31 September 2021 would receive 19.5 years of RHI payments instead of 20 years

Please note that this follows the existing 'tariff guarantee' process:

*Stage 1 application:*

- Information requires includes:
    - Capacity of the system (kW) (must commission within 10% of this)
    - Evidence of planning permission & environmental permits
    - Expected commissioning date (cannot commission before this)
- At this stage the project will be checked against the Tariff Guarantee budget. If there is no budget available, the project will not progress and will be placed in a queue
- Upon approval, Ofgem will issue a Provisional Tariff Guarantee Notice (PTGN)
- No financial information needs to be submitted, but should be ready in preparation for Stage 2

*Stage 2 application:*

- Once Stage 1 has been approved, Stage 2 application must be submitted within 3 weeks
- Evidence that sufficient funds to cover all project costs have been committed to the project, with this evidence verified by an independent auditor
- Upon approval, Ofgem will issue a Tariff Guarantee (TG)

*Stage 3 application:*

- To be made upon commissioning

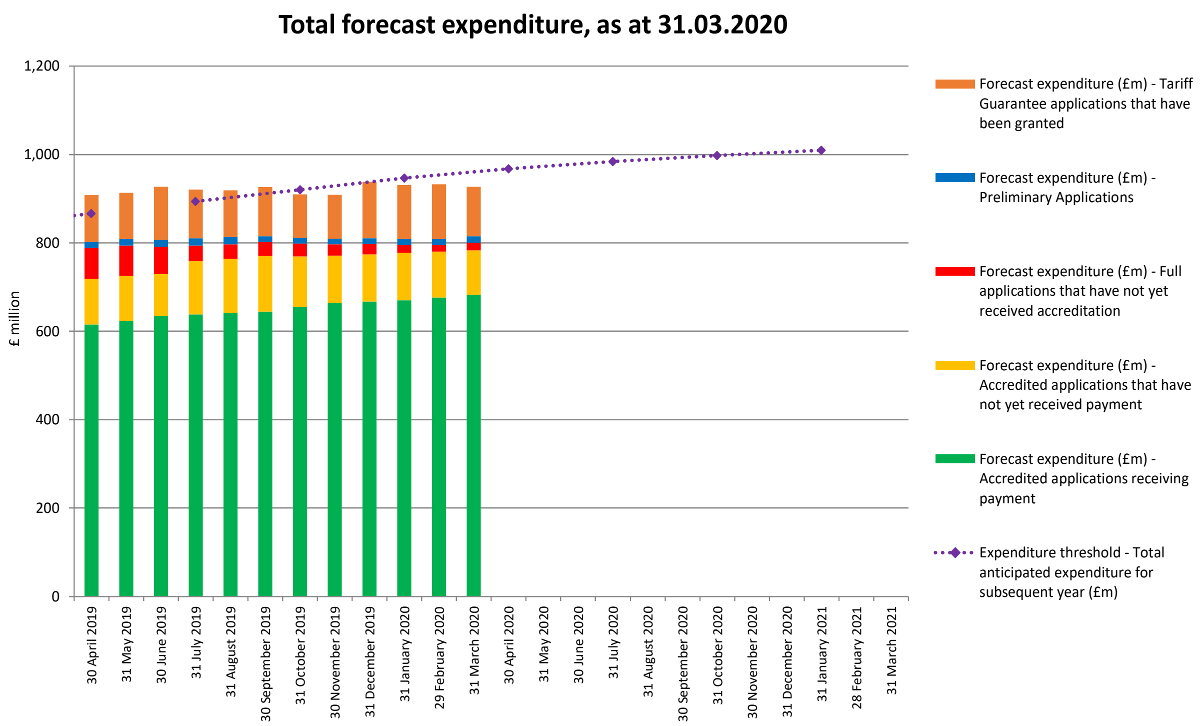
Budget caps

In addition to the overall deadline and tariff guarantee timescales, the RHI scheme includes budget caps on expenditure: one for the overall scheme and one for tariff guarantee applications. The budget caps and expenditure are assessed as a 12-month forecast, so they do not necessarily always increase.

If the overall scheme budget cap is reached, it is likely that the RHI will close entirely for all new applicants. This will be subject to parliamentary approval. The overall budget cap for 2020/21 is £1,150m.

If the TG budget cap is reached, no further TG applications will be accepted. This is written into RHI legislation. The legislation does allow BEIS to increase the TG budget cap; no increases have been made to date and it is unclear whether this would be done in future. The TG budget cap for 2020/21 is £150m.

The chart below shows the overall RHI expenditure (12-month forecast) at around £900m and the TG expenditure (orange) at around £110m. Both are relatively stable, however given the upcoming closure of the RHI scheme, we can assume that both are likely to increase, which means it is possible that one or both of the caps will be met.



Summary

The RHI rate was degressed by 10% in April 2020 and is expected to be reduced further. The project will be able to secure an RHI rate upon submission of a Stage 1 TG application. This requires that full consents are in place, so is expected to be during the Jul-Sep tariff period. We expect a further degression of 20% to take place, giving tariff rates for this project of 6.98 p/kWh (tier 1) and 2.08 p/kWh (tier 2).

There is a risk that the overall RHI budget will be met, which would mean that RHI support cannot be obtained.

There is a risk that the TG budget cap will be met, which would mean that further degressions would apply to the project, resulting in lower tariff rates. This would also increase exposure to the risk of the overall RHI budget being met.

If the project is commissioned after 31 March 2021, the overall period of RHI payments would be reduced accordingly. For example, if commissioned on 31 June 2021, the project would receive 19.75 years of RHI payments.

**Other certifications**

Microgeneration Certification Scheme (MCS) regulations do not apply here, as the installation will have a thermal output of more than 45 kW.

Other certification registrations will be required, such as Part P & G3, GasSafe and OFTEC for the electrical, hot water, gas and heating installation works respectively.

# Finances

**Budget cost**

| Item | Price |
|---|---|
| Building simulation & outline design | £8,800 |
| Detailed design & consenting | £34,500 |
| Viessman Vitocal 300-G heat pumps | £194,084 |
| Heat exchange panels, frame, ground anchors | £250,585 |
| Collector pipework | £100,995 |
| Radiator replacement | £218,203 |
| Other internal heating works | £35,910 |
| Installation & commissioning | £72,600 |
| Accreditation | £950 |
| **Grand total** | **£916,627** |

The heat pumps and emitter parts of this costing are based on quotes received from Viessman and Jaga. The price for collector plates is based on supply by Renewables First.

This cost estimate does not take into account the benefits associated with not needing to relocate the existing boilers and gas supply, or replace the boilers at the end of their lifetime. The heat pump system has an expected lifetime of 20-25 years.

Except for emitter upgrades, the costs above do not include any distribution-side works, such as works to relocate the plant room or improve zoning controls.

**RHI payments**

The expected non-domestic RHI rate, as discussed in the previous section, is 6.98 p/kWh within tier 1 and 2.08 p/kWh within tier 2. The tier 1 rate is paid for all heat delivered up to an equivalent of 1,314 hours per year at peak output (15% capacity factor). The tier 2 rate is paid for heat beyond this. Payments are CPI-linked and guaranteed for 20 years.

All heat delivered by the heat pump system will be eligible for RHI payments, so the total eligible amount is estimated as 600,770 kWh. The overall system, totalling 850 kW installed capacity, has an estimated capacity factor of 8%. This low capacity factor is due to the intermittent heating profile of the building. As the capacity factor is below 15%, the installation will fall entirely within the higher RHI rate.

Please note the comments on RHI deadlines in the previous section.

**Running costs**

Gas supply is currently via Regent Gas with a unit price of 2.829 p/kWh, with a standing charge of £15.82 per day. The climate change levy (CCL) also applies; the latest rate is 0.339 p/kWh.

The existing cost for electricity via HavenPower (from 2018 bill) is around 14.281 p/kWh during 07:00-24:00 and 11.094 p/kWh during 00:00-07:00. The climate change levy (CCL) also applies; the latest rate is 2019 rate 0.847 p/kWh. In addition, a monthly availability fee of £1.52 per kVA applies with a connection rating of 220 kVA, plus monthly standing / data aggregation charges totalling around £50.

The heat pumps do not typically require any more maintenance than the existing gas boilers require. However, a small sum of £900 per year has been included to allow for additional performance monitoring and any minor maintenance of the collector plates.

The long-term cost effectiveness of the heat pump system depends largely on future fuel prices. Oil and gas prices are particularly volatile, whereas electricity prices have been falling, relative to inflation, quite steadily in recent years. However, it is very difficult to predict what fuel prices will be 10 or 20 years from now.

**Performance summary**

The overall expected project performance is shown below. The cost to run the heat pump system will be similar to the existing gas-fired system, and the project is expected to recoup its capital cost in approximately 16 years.

| Item | Value | Units |
|---|---|---|
| Heat pump system rating | 850 | kW |
| Heat supplied by heat pump system | 600,770 | kWh/yr |
| | | |
| **Total project cost (ex. VAT)** | **-£916,627** | |
| | | |
| Units of heat per unit of electricity (SPF) | 4.08 | |
| | | |
| Electricity price | 15.1 | p/kWh |
| Existing fuel price | 3.2 | p/kWh |
| RHI rate | 6.98 | p/kWh |
| **RHI annual payments** | **£41,934** | |
| RHI period | 20 | years |
| | | |
| Annual cost to run existing heating system | -£23,210 | |
| Annual cost to run heat pump system | -£23,176 | |
| **Annual fuel saving** | **£35** | |
| | | |
| Payback period | - | years |
| Project IRR (20 years) | - | |
| Potential annual carbon saving | 110,566 | kg $CO_2e$ |

Based on current fuel prices and the initial estimates above, the project would not quite pay for itself within its lifetime. To achieve project payback within 20 years, the capital cost would need to be reduced to £830,000. This may be possible, particularly if further work demonstrates that a slightly lower system rating would be sufficient.

Please also note that the cost of replacing the existing gas boilers has not been taken into account.

**Carbon footprint**

The current government conversion factors for greenhouse gas reporting are:

- Natural gas 0.1840 kg CO2e / kWh (gross CV)
- Electricity 0.2556 kg CO2e / kWh

The existing carbon footprint is estimated as 110,566 kg CO2e. By switching from gas to heat pumps using a standard electricity tariff this would reduce to 40,198 kg, a reduction of more than 60%. Alternatively, a 100% renewable tariff could be used (at additional cost) to eliminate the carbon footprint entirely.

# Summary & next steps

**Key findings**

Ebley Mill has a total peak heat demand, after gains, of approximately 850 kW. The building is heated during weekday daytimes only, with an overall annual heat demand of approximately 600,770 kWh in 2019.

Our initial assessment of emitter specification suggests that the peak demand may be lower than 850 kW. To resolve this difference, a more accurate model of heat demand may be required, in particular to account for intermittent heating.

The existing heating system consists of five gas-fired boilers with a total rated output of approximately 945 kW, in addition to electric convector heaters in the council chamber. All hot water is electrically heated at the point of use.

The adjacent canal and river both provide opportunities for installation of a water-source heat pump. This could be an open-loop system, abstracting water via a series of pumps, filters and intermediate heat exchangers, or a closed-loop system using stainless steel heat exchange panels.

Due to the lower maintenance requirements and ease of consenting, we recommend a closed-loop installation, with panels fixed onto the river bed using ground anchors. Collector pipework would then lead through the building to the proposed plant room, which is the existing boiler house in Bodley Block.

The heat pump system would provide all space heating requirements for the building, with a recommended flow temperature of 50°C to ensure a high system efficiency, providing around 4.1 units of heat per unit of electricity. This will require replacement of most radiators throughout the building, either with higher output traditional radiators or low-temperature fan-assisted radiators.

Ideally the New Block heating circuit would be connected to the Bodley/Long Block circuit, so that the heat pump system works entirely from the plant room in Bodley Block. Alternatively, a separate heat pump system with separate collector circuit could be installed in the New Block boiler room.

A bivalent system was considered, which would retain the existing gas boilers for use during cold weather. However, this arrangement would not improve the project payback and would significantly reduce the carbon savings, so is not recommended unless there is a strong driver to minimise capital costs.

The total project cost is estimated at approximately £917,000. Based on current fuel prices and the initial estimates above, the project would not quite pay for itself within its lifetime. To achieve project payback within 20 years, the capital cost would need to be reduced to £830,000. This may be possible, particularly if further work demonstrates that a slightly lower system rating would be sufficient. Please also note that the cost of replacing the old boilers has not been taken into account.

A $CO_2e$ saving of up to 110 tonnes per year could be achieved, which would be a significant contribution to reducing the council's carbon footprint. The project would also pave the way for further similar installations at other buildings within the Stroud area.

If the council wishes to carry out this installation, it is critical that the project should be developed quickly in order to secure the highest possible RHI rate. To minimise the effects of RHI degression, consents for the project would need to be obtained during the Jul-Sep tariff period.

**Next steps**
To obtain additional real data on the building heat loss and emitter outputs, we will test the heating as described in the 'building details' section above. This will provide useful data to validate the heat demand estimates.

The following step would be detailed design, starting with using a building physics software package to model the heat demand in greater detail, including a more accurate representation of how factors such as intermittent heating and solar gains affect the heat demand.

If preferred, this software modelling could be completed as a standalone item prior to the main design and build contract. The benefit of this would be to identify whether the overall project finances can be improved, before entering the formal tender process. However, if the project finances are acceptable, it would be simpler to include this step as part of the design and build contract, providing there is flexibility to allow the installation scale to be varied as required.

The project timeline is expected to be as follows:

| | |
|---|---|
| **Jun 2020** | Detailed design & consent applications |
| **Sep 2020** | Consents granted |
| **Sep 2020** | Stage 1 Ofgem application |
| **1 Oct 2020** | *RHI degression (if Stage 1 Ofgem application not submitted)* |
| **Oct 2020** | Stage 2 Ofgem application* |
| **Nov 2020** | Completion of remaining design work |
| **Dec 2021** | Place order for main components |
| **May 2021** | Installation & commissioning |
| **May 2021** | Stage 3 Ofgem application |

**please note that arrangements for project financing need to be finalised by this point.*

We feel this report demonstrates that the project will provide significant environmental benefits whilst also repaying the vast majority of its installation costs. We hope to work with you to deliver the remaining stages of this project.

# STROUD DISTRICT COUNCIL

AGENDA ITEM NO

# 7

## STRATEGY AND RESOURCES COMMITTEE

## 9 JULY 2020

## WORK PROGRAMME

| Date of meeting | Matter to be considered | Reporting Member/Officer |
|---|---|---|
| 8.10.20 | Member\Officer reports to be circulated prior to Committee:<br>a) Performance Monitoring<br>b) Investment and Development Panel<br>c) Leadership Gloucestershire Update<br>d) Gloucestershire Economic Growth Joint Committee (GEGJC)<br>e) Gloucestershire Economic Growth Scrutiny Committee (GEGSC)<br>f) Recovery Strategic Board | <br><br>Councillors Cooper & Pearson<br>Chair<br>Chief Executive<br>Chair & Chief Executive<br><br>Councillor Pickering<br><br>Strategic Director of Place |
| | Work Programme | Committee |
| | GFirst Lep – invite to attend | |
| | Stroud Cemetery Chapel | Property Manager |
| | Kingshill House | Property Manager |
| | Brimscombe Port Redevelopment | Head of Property Services |
| | CIL Strategic Funding Recommendations | Housing Strategy and CIL Manager |
| | Budget Strategy | Strategic Director of Resources |
| | Finance Outturn Report 2019/20 | Strategic Director of Resources |
| | Procurement Annual Update | Senior Policy and Governance Officer |
| | Q1 Corporate Peer Challenge Action Plan Update | Policy and Performance Officer |
| | Q1 Corporate Delivery Plan Update | Policy and Performance Officer |
| | Q1 Budget Monitoring Report | Strategic Director of Resources |
| 10.12.20 | Member\Officer reports to be circulated prior to Committee:<br>a) Performance Monitoring<br>b) Investment and Development Panel<br>c) Leadership Gloucestershire Update<br>d) Gloucestershire Economic Growth Joint Committee (GEGJC)<br>e) Gloucestershire Economic Growth Scrutiny Committee (GEGSC)<br>f) Recovery Strategic Board | <br><br>Councillors Cooper & Pearson<br>Chair<br>Chief Executive<br>Chair & Chief Executive<br><br>Councillor Pickering<br><br>Strategic Director of Place |
| | Work Programme | Committee |
| | Review of the Council Tax Hardship Scheme Covid-19 and Discretionary Housing Benefit | Head of Revenue and Benefits |
| | Q2 Corporate Peer Challenge Action Plan Update | Policy and Performance Officer |
| | Q2 Corporate Delivery Plan Update | Policy and Performance Officer |
| | Q2 Budget Monitoring Report | Strategic Director of Resources |

| Date of meeting | Matter to be considered | Reporting Member/Officer |
|---|---|---|
| 28.01.21 | Member\Officer reports to be circulated prior to Committee:<br>a) Investment and Development Panel<br>b) Leadership Gloucestershire Update<br>c) Gloucestershire Economic Growth Joint Committee (GEGJC)<br>d) Gloucestershire Economic Growth Scrutiny Committee (GEGSC)<br>e) Recovery Strategic Board | <br>Chair<br>Chief Executive<br>Chair & Chief Executive<br>Councillor Pickering<br>Strategic Director of Place |
| | Work Programme | Committee |
| | Council Tax Support Scheme 2021/22 | Head of Revenue and Benefits |
| | Q3 Corporate Peer Challenge Action Plan Update | Policy and Performance Officer |
| | Q3 Corporate Delivery Plan Update | Policy and Performance Officer |
| | Budget Setting 2021/22 | Strategic Director of Resources |
| 04.03.21 | Member\Officer reports to be circulated prior to Committee:<br>a) Performance Monitoring<br>b) Investment and Development Panel<br>c) Leadership Gloucestershire Update<br>d) Gloucestershire Economic Growth Joint Committee (GEGJC)<br>e) Gloucestershire Economic Growth Scrutiny Committee (GEGSC)<br>f) Recovery Strategic Board | <br>Councillors Cooper & Pearson<br>Chair<br>Chief Executive<br>Chair & Chief Executive<br>Councillor Pickering<br>Strategic Director of Place |
| | Work Programme | Committee |
| | Q3 Budget Monitoring Report | Strategic Director of Resources |
| 22.04.21 | Member\Officer reports to be circulated prior to Committee:<br>a) Investment and Development Panel<br>b) Leadership Gloucestershire Update<br>c) Gloucestershire Economic Growth Joint Committee (GEGJC)<br>d) Gloucestershire Economic Growth Scrutiny Committee (GEGSC)<br>e) Recovery Strategic Board | <br>Chair<br>Chief Executive<br>Chair & Chief Executive<br>Councillor Pickering<br>Strategic Director of Place |
| | Work Programme | Committee |
| | Q4 Corporate Peer Challenge Action Plan Update | Policy and Performance Officer |
| | Q4 Corporate Delivery Plan Update | Policy and Performance Officer |

**Items for Future Meetings**

- The Changing Future of Play Areas – Head of Housing Services, Community Services Manager
- Modernisation Programme –Workshop – Strategic Director of Transformation and Change
- Cotswold Canal Project – Bid to National Heritage Lottery Fund – Canal Manager
- Asset Review

**Information Sheets**

| Ref/Date | Topic | Author(s) |
|---|---|---|
| SR-2020/21-001 18/06/2020 | Corporate Delivery Plan Progress Quarter 4 | Policy and Performance Officer |