



Groundschool, Irongate Farm, Weston, Hertfordshire, SG4 &DR

# Options Appraisal

29/07/2025

# Table of Contents

|    |                                             |    |
|----|---------------------------------------------|----|
| 1  | Summary .....                               | 2  |
| 2  | Methodology.....                            | 4  |
| 3  | Energy modelling .....                      | 5  |
| 4  | Technology options .....                    | 11 |
| 5  | Building systems .....                      | 16 |
| 6  | Environmental impact.....                   | 17 |
| 7  | Planning and legislation requirements ..... | 18 |
| 8  | Next steps .....                            | 19 |
| 9  | Detailed summary tables .....               | 20 |
| 10 | Terms and abbreviations.....                | 21 |
| 11 | Assumptions.....                            | 22 |
| 12 | Disclaimer of liability.....                | 31 |

# 1 Summary

The client has engaged Lùths to appraise the various options available for the range of building services required for the Irongate Farm in Weston, Hertfordshire. The clients run an annual conference/festival on regenerative agriculture and are exploring the possibility of establishing a more permanent and year-round centre - 'Groundschool' - on the farm to enhance their educational and outreach capacity. The site currently has a collection of existing barns for agricultural purposes and we are considering developing a phased plan around this, including getting the school up and running, and later introducing other enterprises

Lùths started the appraisal by modelling the energy demands of the building based on the supplied information, industry benchmarks and with insight from our records of similar buildings.

A summary of the estimated annual energy demands is shown in Table 1:

|                               | Scenario 1<br>Building Standards | Scenario 2<br>Buildings Standards (-10%) | Scenario 3<br>(Enerphit) |
|-------------------------------|----------------------------------|------------------------------------------|--------------------------|
| Space heating (kWh)           | 34,736                           | 32,300                                   | 13,548                   |
| Hot water heating (kWh)       | 9,298                            | 9,298                                    | 9,298                    |
| Cooling (kWh)                 | 16,521                           | 16,625                                   | 18,019                   |
| Other electricity (kWh)       | 33,760                           | 33,760                                   | 33,760                   |
| Heating plant (kW)            | 50.80                            | 49.04                                    | 20.65                    |
| Domestic hot water plant (kW) | 35.18                            | 35.18                                    | 35.18                    |
| Cooling plant (kW)            | 49.68                            | 48.53                                    | 45.83                    |

Table 1: estimated annual energy demand summary

Next, we assessed the suitability of a number of technology options for the energy and generation systems to meet the demands and suggested the necessary building systems to distribute the heat and air around the building. We then created a shortlist from these options and established the costs and benefits of each. A summary of the capital and operating costs is given in Table 2 and Figure 1:

|                                   | Baseline<br>(Electrical) | ASHP     | GSHP     | Biomass<br>(pellet) | Hybrid<br>(Biomass<br>Log and<br>GSHP) |
|-----------------------------------|--------------------------|----------|----------|---------------------|----------------------------------------|
| Heating System Cost               | £21,000                  | £117,600 | £211,025 | £101,053            | £162,302                               |
| DHW System Cost                   | £6,000                   | £6,000   | £6,000   | £6,000              | £6,000                                 |
| Ventilation System Cost           | £15,000                  | £85,000  | £85,000  | £85,000             | £85,000                                |
| Additional Costs (Grid)           | £15,000                  | £6,000   | £6,000   | £-                  | £6,000                                 |
| Total Capital Costs               | £61,200                  | £248,260 | £353,228 | £255,761            | £299,632                               |
| Net capital costs                 | £61,200                  | £248,000 | £353,000 | £256,000            | £300,000                               |
| Heating & Hot Water Running Costs | £19,971                  | £9,243   | £7,530   | £8,572              | £7,006                                 |
| Electricity Running Costs         | £15,158                  | £15,158  | £15,158  | £15,158             | £15,158                                |

|                                                                          |          |          |          |          |          |
|--------------------------------------------------------------------------|----------|----------|----------|----------|----------|
| <b>Total Annual Running Costs (Inc servicing, standing charges, etc)</b> | £36,100  | £25,400  | £23,700  | £24,700  | £23,200  |
| <b>Net annual costs</b>                                                  | £36,100  | £25,400  | £23,700  | £24,700  | £23,200  |
| <b>Cumulative costs 10 years</b>                                         | £470,000 | £535,000 | £621,000 | £535,000 | £562,000 |
| <b>Cost parity (years)</b>                                               | n/a      | 16       | 20       | 16       | 17       |
| <b>Annual emissions (tCO2e)</b>                                          | 10.64    | 7.39     | 6.87     | 8.49     | 6.92     |

Table 2: technology options summary

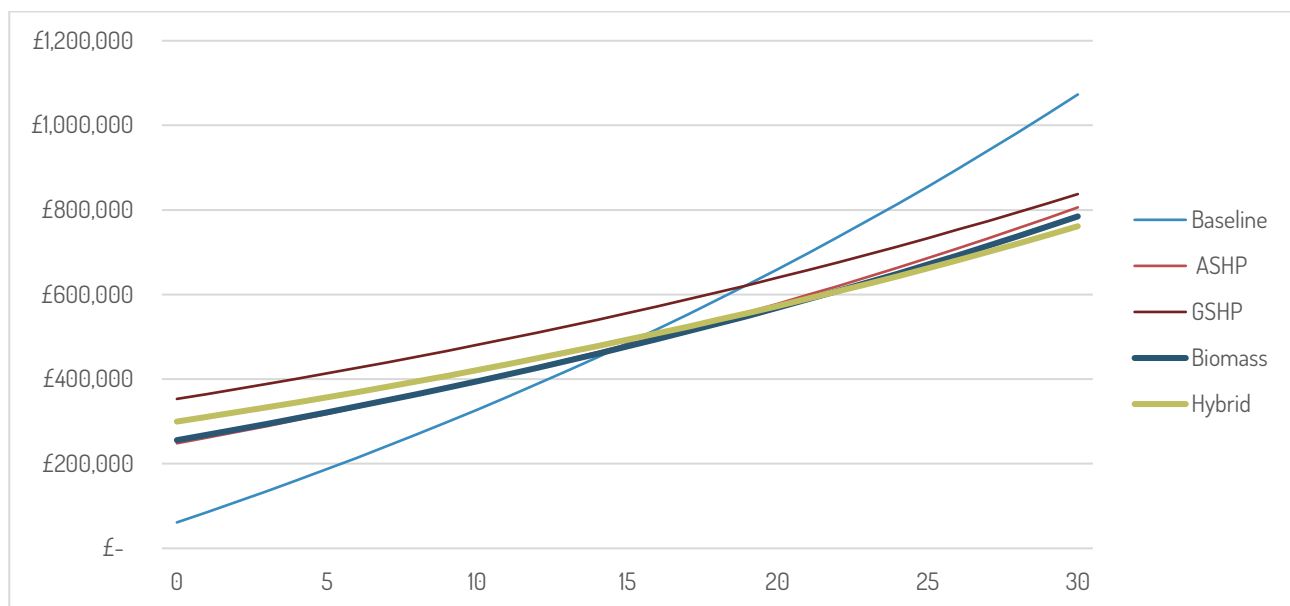


Figure 1: cumulative costs for each technology option, year on year

Based on our modelling, we propose the following scenarios:

| Scenario 1                                                                                                                             | Scenario 2                                                                                                                                      | Scenario 3                                                                                                                                        |
|----------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>• Building Fabric meets Building Standards</li> <li>• Mechanical Extract Ventilation</li> </ul> | <ul style="list-style-type: none"> <li>• Building Fabric exceeds Building Standards by 10%</li> <li>• Mechanical Extract Ventilation</li> </ul> | <ul style="list-style-type: none"> <li>• Building fabric meets EnerPHit Standards</li> <li>• Mechanical Ventilation with Heat Recovery</li> </ul> |

The remainder of this report expands on our appraisal methodology, how we complete the energy modelling, a description of the technology options and building systems, and our suggested next steps for the project.

Our recommended solution is:

- Heating (Main)- GSHP
- Heating Backup- Biomass (log boiler) allows use of clients own fuel
- Cooling- allows free cooling from GSHP. Try use projections to reduce solar gain and natural ventilation as well
- DHW- From GSHP
- Additional – Solar PV
- Ventilation- Mechanical Ventilation with Heat recovery in main areas. Separate Kitchen Ventilation (balanced)

## 2 Methodology

### 2.1 Energy modelling

At Lùths, we use the energy modelling software IES Virtual Environment to model the likely heating and cooling demands for the proposed building. The software allows us to create a three-dimensional dynamic model to establish the energy and power demands by calculating building fabric heat losses, ventilation heat losses, domestic hot water demands, system losses and thermal response.

The model also considers the heat gains from occupancy, equipment, lighting, and solar gains. The thermal demands are based on internal temperature settings and local outside temperature data over the course of a reference year for the proposed location.

In addition to the requirements of maintaining the prescribed temperatures in the various spaces, there may be other equipment which may have a heating or cooling requirement. However, for the purposes of this initial appraisal, we have only shown the energy demands associated with the spaces, the lighting and basic equipment. Lùths can develop the energy modelling in a later detail design stage if they make sense to the client from a whole-system efficiency and cost perspective.

### 2.2 Technology options

Lùths have developed energy, emissions and financial scenarios to help appraise the options from currently available technology, the client's suggestions, and solutions which are likely to help the building comply with the various regulations.

After the energy loads are confirmed, we use our database and experience of existing installations to suggest likely capital and operational costs for each option, presented over the predicted lifetime of the equipment.

## 2.3 Building systems

Most of the technology options for energy sources or generation can use the same ancillary building services. One caveat is when planning the type of heating emitters. For example, some emitters such as underfloor or air heating systems generally work at lower temperatures than traditional radiator systems. An integrated design approach will help match energy generation with delivery and is employed in this appraisal.

Another consideration is the extent of heat recovery measures to be employed. It is almost universal to specify a heat recovery device in tandem with the mechanical ventilation system. It is becoming more common to design an integrated heat recovery system with waste hot water, especially with buildings with high hot water usage profiles.

The distribution systems for heating water, hot water and ventilation air are all assumed to be designed in accordance with best-practice and industry standards.

# 3 Energy modelling

## 3.1 Building fabric

All conditioned spaces are assumed to be within the “thermal envelope” of the building. By examining the composition of the building elements, we can assess each element’s thermal transmittance, (also known as its U-value) and build a picture of the heat loss rate through the building. We also use as-measured airtightness data where available, or industry guidance to estimate the energy lost through air through the leaks in the building fabric.

A summary of the building fabric standards is shown below:

|                                                          | Scenario 1 | Scenario 2 | Scenario 3 |
|----------------------------------------------------------|------------|------------|------------|
| Floors U-value (W/m <sup>2</sup> )                       | 0.13       | 0.12       | 0.13       |
| Walls U-value (W/m <sup>2</sup> )                        | 0.18       | 0.16       | 0.15       |
| Roofs U-value (W/m <sup>2</sup> )                        | 0.13       | 0.12       | 0.13       |
| Windows U-value (W/m <sup>2</sup> )                      | 1.20       | 1.20       | 0.85       |
| Doors U-value (W/m <sup>2</sup> )                        | 1.20       | 1.20       | 0.85       |
| Roof windows U-value (W/m <sup>2</sup> )                 | 1.20       | 1.20       | 1.10       |
| Infiltration at 50Pa (m <sup>3</sup> /m <sup>2</sup> .h) | 5.0        | 4.5        | 1.0        |

Table 3: Building fabric summary

## 3.2 Ventilation

We have made assumptions about the quantities of fresh air delivered to and stale extracted from the building by infiltration and exfiltration of air through leaks in the building fabric, controlled natural ventilation from window and door openings, as well as through the supply of fresh air and exhaust of stale air from ventilation systems. We have estimated the amount energy gained or lost with each air exchange calculated as per CIBSE guidance.

Infiltration-exfiltration air exchanges through leaks in the building fabric can be estimated at the design stage but are often difficult to predict exactly. As-built airtightness tests are required to understand the quantities and to update energy models. New builds routinely achieve an air permeability through the fabric of around 1 to 2m<sup>3</sup>/m<sup>2</sup>·h (at the test pressure of 50Pa). While this is still relatively airtight, it is possible to go even lower should the client and architect specify. Passivhaus requires an airtightness of no more than 0.6 air changes per hour, which depending on the geometry of the building, corresponds to below 0.5m<sup>3</sup>/m<sup>2</sup>·h.

Natural air exchanges – by the controlled opening of windows and doors – usually occur when occupants feel they need more control over the temperature or air quality of a particular space. While this is a common and perfectly normal practice, this becomes less of a requirement and more simply a possibility in very airtight buildings with mechanical ventilation systems, and so is often not considered as a source of energy loss or gain.

At low rates of infiltration, there can be problems with internal air quality and condensation unless full active ventilation is used for both supply and extract. Because of this, mechanical ventilation systems are now commonplace, especially so in more airtight buildings. The amount of fresh air delivered to, and stale air extracted from spaces can be stipulated at the design stage and the associated energy losses and gains can be modelled to a greater degree of accuracy.

Heat loss through air exchanges can account for a large proportion of the total heat loss. In light of this, it is now common to specify a mechanical ventilation system with heat recovery (MVHR), which often achieve heat recovery rates of over 90%, greatly reducing the energy demand of the building.

We have used the below figures in our modelling:

|                                                                 |             |
|-----------------------------------------------------------------|-------------|
| <b>Air permeability (ACH)</b>                                   | <b>0.33</b> |
| <b>Air Test Target (m<sup>3</sup>/m<sup>2</sup>/hr at 50Pa)</b> | <b>5</b>    |
| <b>MVHR efficiency (%)</b>                                      | <b>80%</b>  |

Table 4: air infiltration and heat recovery efficiency

## 3.3 Domestic hot water

Hot water is usually generated at the time of use, or the energy stored in anticipation of a daily use profile in a dedicated thermal store or hot water storage tank. Hot water systems are designed to meet the comfort requirement of always having hot water available, while managing the risk associated with Legionella at mild storage temperatures.

The domestic hot water (DHW) requirement and the energy associated with its generation has been calculated from the peak day according to the method in BS6700 and CIBSE Guide G.

We have assumed each energy scenario and technology option has a relatively similar hot water profile.

|                             |       |
|-----------------------------|-------|
| Average number of occupants | 35    |
| Daily hot water (litres)    | 1,200 |
| Time to recharge (hours)    | 2.0   |

Table 5: hot water sizing

Heat lost from hot water storage and distribution pipework can sometimes be considered as a useful heating gain in winter, however we consider this as waste heat in summer.

## 3.4 Energy gains and losses

We can estimate the heat lost through the walls, roof, floors, windows and doors of the fabric, by infiltration and exfiltration of air through leaks in the building fabric, controlled natural ventilation window and door openings, as well as through the supply of fresh air and exhaust of stale air from ventilation systems. Additional losses can be assumed from uncontrolled door and window openings, and the heat in waste water for example.

Solar gains are based on the window areas as shown on each facade of the architect's model and are calculated as per CIBSE guidance. We have assumed the least favourable conditions for solar gain with no blinds or shutters. This represents the worst case for overheating and allows us to better visualise where overheating measures may be implemented. Likewise, for the winter 'design day' – the most challenging conditions for the building – we have again assumed the worst case for heat gain, there being no solar gains.

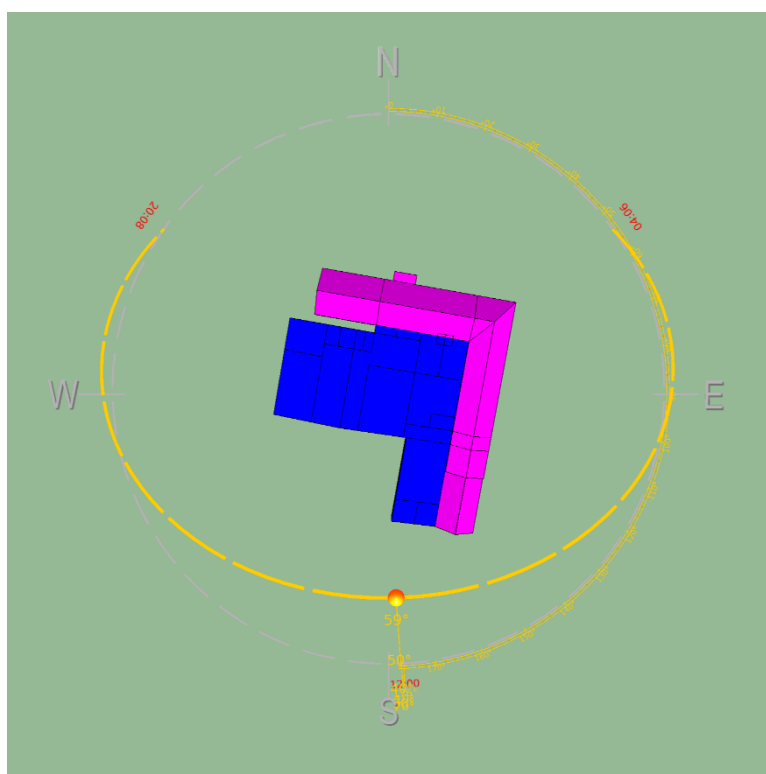


Figure 2: model orientation

Gains from occupancy, lighting and equipment are also modelled following CIBSE guidance.

## 3.5 Modelling results

With the various inputs collated, we used the energy modelling software IES-VE to predict the likely heating and cooling demands for the proposed building.

From this we have established an energy demand profile for a typical year as in Table 1: estimated annual energy demand summary, repeated below:

|                         | Scenario 1 | Scenario 2 | Scenario 3 |
|-------------------------|------------|------------|------------|
| Space heating (kWh)     | 34,736     | 32,300     | 13,548     |
| Hot water heating (kWh) | 9,298      | 9,298      | 9,298      |
| Cooling (kWh)           | 16,521     | 16,625     | 18,019     |
| Other electricity (kWh) | 33,760     | 33,760     | 33,760     |

Table 6: estimated annual energy demand summary, as per Table 1

We similarly calculate the power requirement required for the various plant based on predicted peaks and periods of extended demand. The pattern of heating demand over a typical year is shown below (for scenario 1- building regulations):

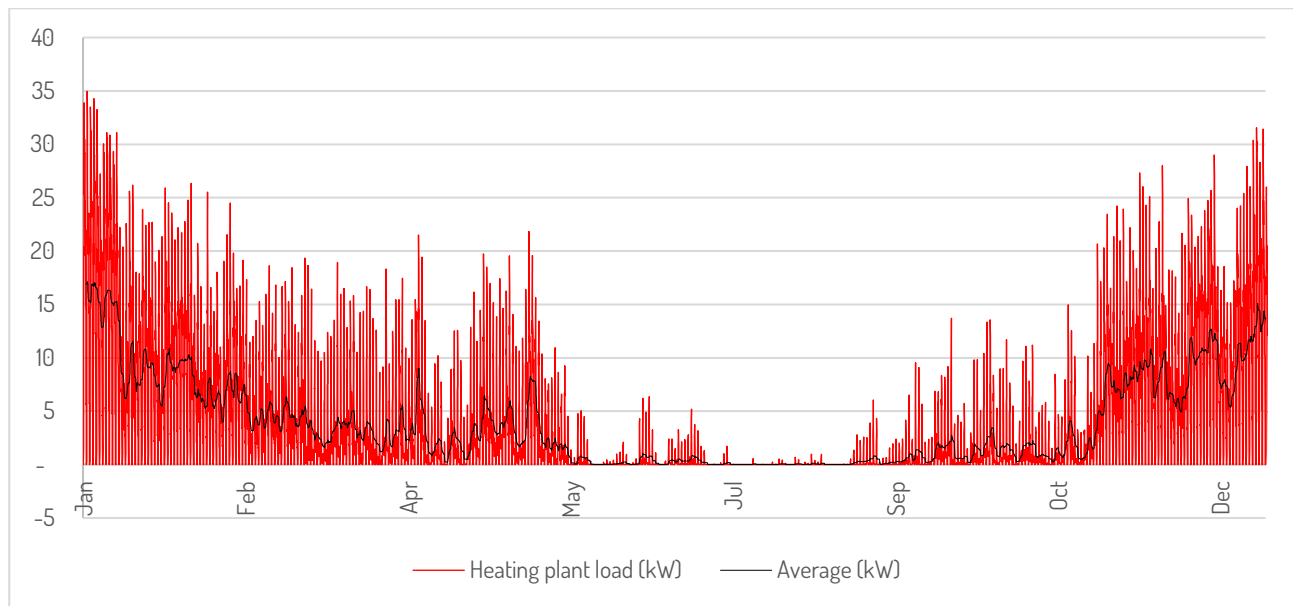


Figure 3: model results for heating requirement over the model year

The pattern of heating demand over the peak day is shown below:

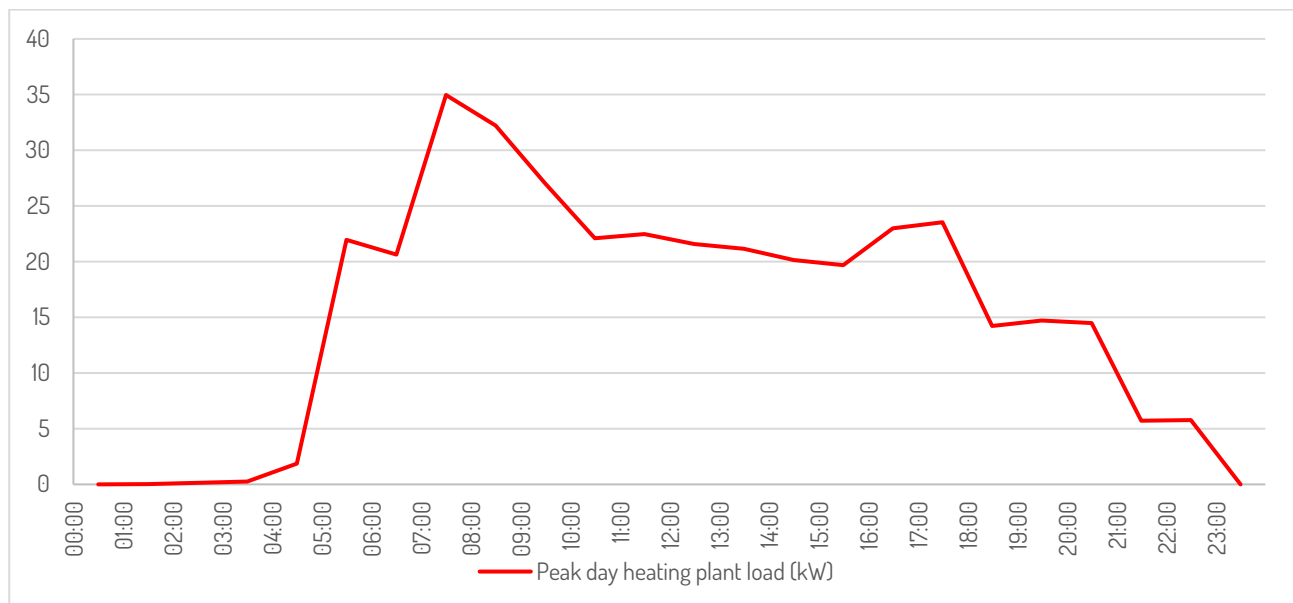


Figure 4: model results for heating requirement over the model peak day

The pattern of cooling demand over a typical year is shown below:

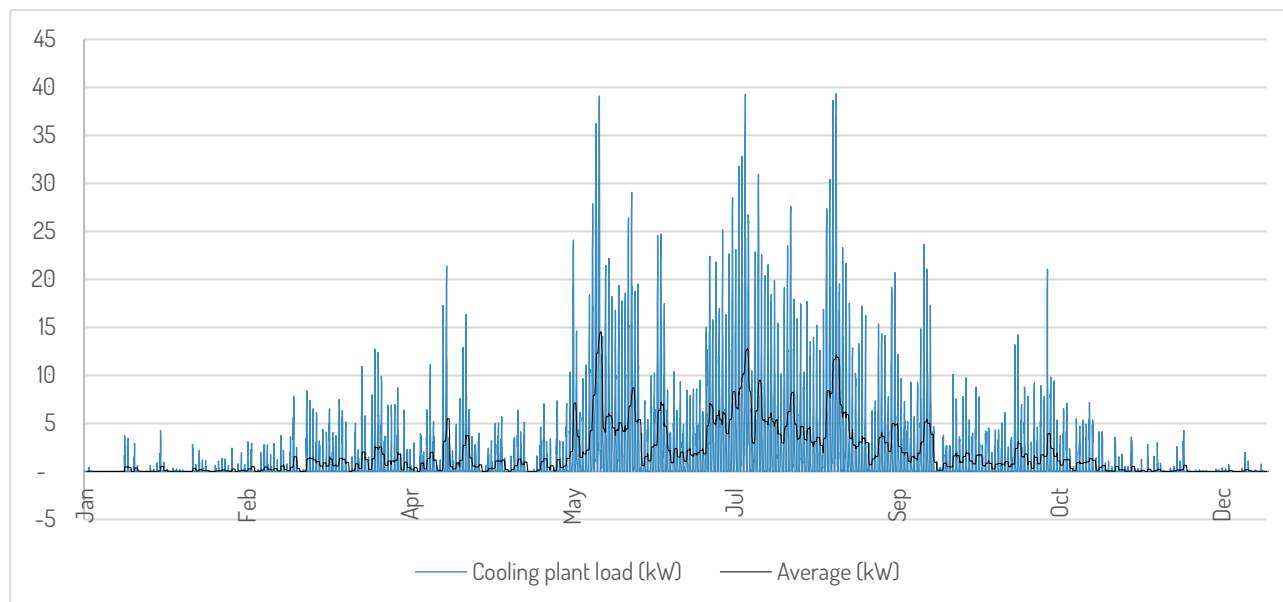


Table 7: model results for cooling requirement over the model year

From this modelling, we have suggested heating and cooling plant output sizing as shown below:

|                               | Scenario 1 | Scenario 2 | Scenario 3 |
|-------------------------------|------------|------------|------------|
| Heating plant (kW)            | 50.80      | 49.04      | 20.65      |
| Domestic hot water plant (kW) | 35.18      | 35.18      | 35.18      |
| Cooling plant (kW)            | 49.68      | 48.53      | 45.83      |

Table 8: heating and cooling plant sizing

It should be noted that our modelling is based on a heating profile which ensures the building is uniformly heated to a nominal room temperature. While modelling this way provides a fair comparison between each heating system type, our energy data and costs may vary from real-world usage and billing, especially in the case of existing buildings which may be under-heated, or buildings with unusual operating profiles.

Equipment sizing and energy use can also vary depending on the technology used. Heat pump heating systems are typically designed to run for longer periods at lower flow temperatures, while conventional boilers typically run intermittently at higher temperatures.

A summary of other modelling inputs and safety factors are as below:

|                                 |              |
|---------------------------------|--------------|
| Weather file                    | London Luton |
| Design outdoor temp (°C)        | -3.8         |
| Location exposure correction    | 0%           |
| Intermittent heating correction | 0%           |

|                              |      |
|------------------------------|------|
| High ceilings correction     | 0%   |
| Thermal bridging correction  | 2%   |
| Distribution loss correction | 3%   |
| CIBSE percentile             | 99%  |
| CIBSE peak heat load (kW)    | 50.8 |

Table 9: design inputs and safety factors

## 3.6 Compliance with regulations

The current version of the Simplified Building Model (SBEM) is used for building regulation compliance for new non-domestic buildings. The building regulations, require that the calculated carbon dioxide emissions (CO<sub>2</sub> kg/m<sup>2</sup>/year) for the proposed new build, known as the building emissions rate (BER), should be less than or equal to the target carbon dioxide emissions for a 'notional building' of the same size, the so-called target emissions rate (TER).

In England, for assessments of new buildings using non-carbon emitting heating systems such as heat pumps, the only metric used for assessment is the Building Delivered Energy Rate (BDER) measured against a target rate (TDER).

In renovation projects, gas, LPG, oil, and direct-electrical heating systems (other than heat pumps) usually need an addition of solar PV to help them pass the current requirements and to offset emissions. While all-electrical heating solutions save on upfront capital costs, they often require additional spend on solar PV for example, to help them pass the compliance tests.

## 4 Technology options

The modelled energy scenarios can be met with the following energy source and generation technology options:

1. **Baseline:** all-electric heating used as a baseline to highlight the improvements possible with the other options
2. **ASHP:** air source heat pump with radiators and UFH
3. **GSHP:** ground source heat pump with radiators and UFH
4. **Biomass:** biomass boiler fuelled by wood pellets with radiators and UFH
5. **Hybrid:** ground source heat pump with UFH and biomass boiler fuelled by wood logs with radiators

The summary below sets out the advantages, disadvantages, and project suitability of the options that were deemed credible at this stage.

## 4.1 Baseline: All-Electric Heating

**Suitability:** Potentially suitable – the client may wish to examine the cost-benefit in more detail.

All – Electric Heating can either be via electric heaters or an electric boiler. An electric boiler works the same as a natural gas boiler would however is 100% efficient unlike a natural gas boilers which is around 88% efficient.

Electric radiators are a simple option, however, relying on electrical heating can be expensive as the unit cost of electricity is expensive. Electric heaters are easily controlled individually and so their use can be minimised in areas where you do not want to heat, directly reducing electricity usage.

| Advantages                                                                                       | Disadvantages                                                                                                     |
|--------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|
| Electric heaters are easy to install and can be used when and where they are needed as a top up. | High costs of all-electric heating.<br>Grid connection may not be large enough to support this making it unviable |

## 4.2 ASHP

**Suitability:** Suitable – There is space available for external condensers for the boiler house. However, ASHPs have a lower efficiency compared to GSHPs therefore higher carbon dioxide emissions and fuel costs.

- An ASHP essentially involves an exchanger unit, usually in a fan outside the property, which will use a small amount of electricity to gather heat from the ambient air to then heat up an internal wet system. Although the upfront costs are high, they have running cost savings as they are typically 300+% efficient.
- The noise coming from these size ASHP units means that they must be at least 20 m away from the surrounding buildings (neighbours) if no barrier is installed around the ASHP units to help block the noise. If a barrier is put in place the distance to the surrounding buildings only needs to be 8 m away.
- The ASHP is 42db at 8m distance
- Electrical connections on site must be inspected prior to the installations of new ASHPs to ensure that they are of sufficient load capacity.

| Advantages                                                                                       | Disadvantages                                                                                                                                                                         |
|--------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| No boreholes are required which significantly reduces capital costs. Low Capex compared to GSHP. | Not as efficient as GSHPs. Not as aesthetically pleasing as some other technologies. The ASHP units are quite visible and produce low level noise so need to be positioned carefully. |

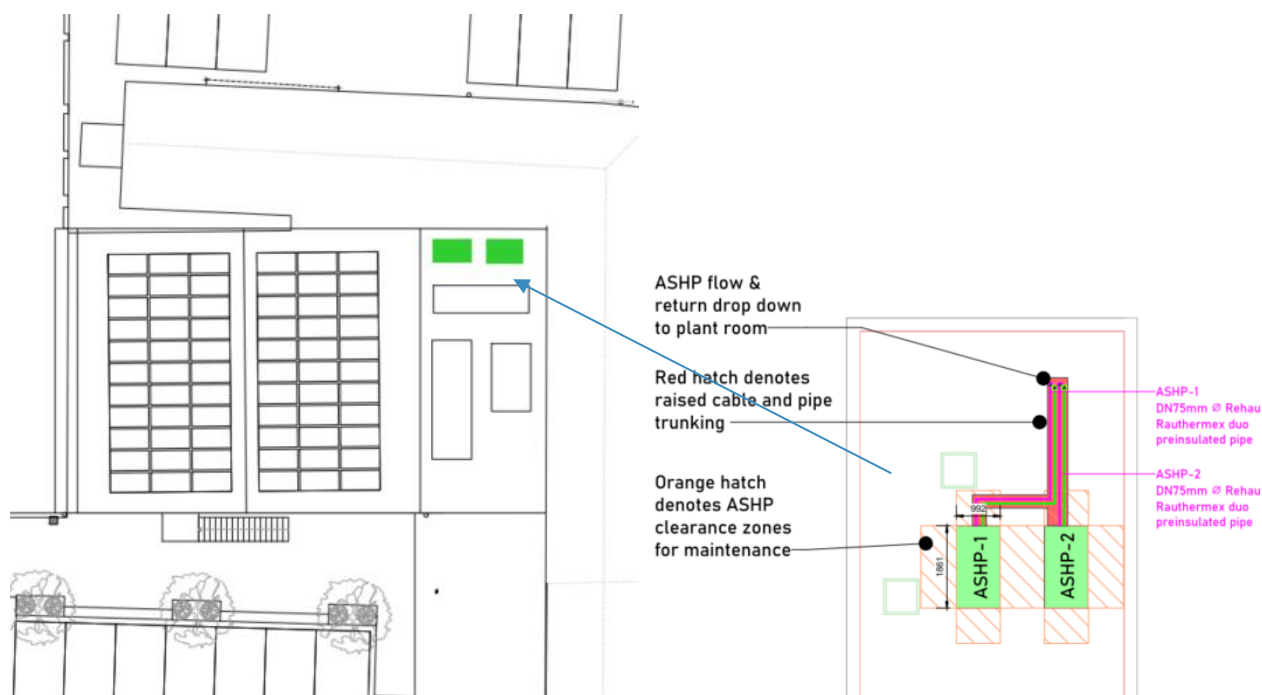


Figure 5: proposed ASHP locations on site plan

## 4.3 GSHP

**Suitability:** Suitable – There is space available for a vertical ground source system using boreholes. However, it is an expensive installation, and the savings achieved might not be sufficient to make this technology cost effective. GSHP boreholes need to be 6 m away from any neighbouring object (trees, buildings etc).

GSHPs deliver similar results to ASHPs, but with slightly higher efficiencies as they gather heat from the ground which has a more stable and on average slightly higher ambient temperature than the air, particularly in winter.. The GSHPs estimated in this document are the more common borehole options, where pipes are fed deep underground (up to 200m).

- Our borehole calculations are based on a heat distribution network for the whole site. We have estimated that you may need approx. 5 × 200 m boreholes, however, this needs further design if you want to go ahead. The boreholes are approx. 130 mm diameter and need to be approx. 6–8 m apart (see Figure 10).

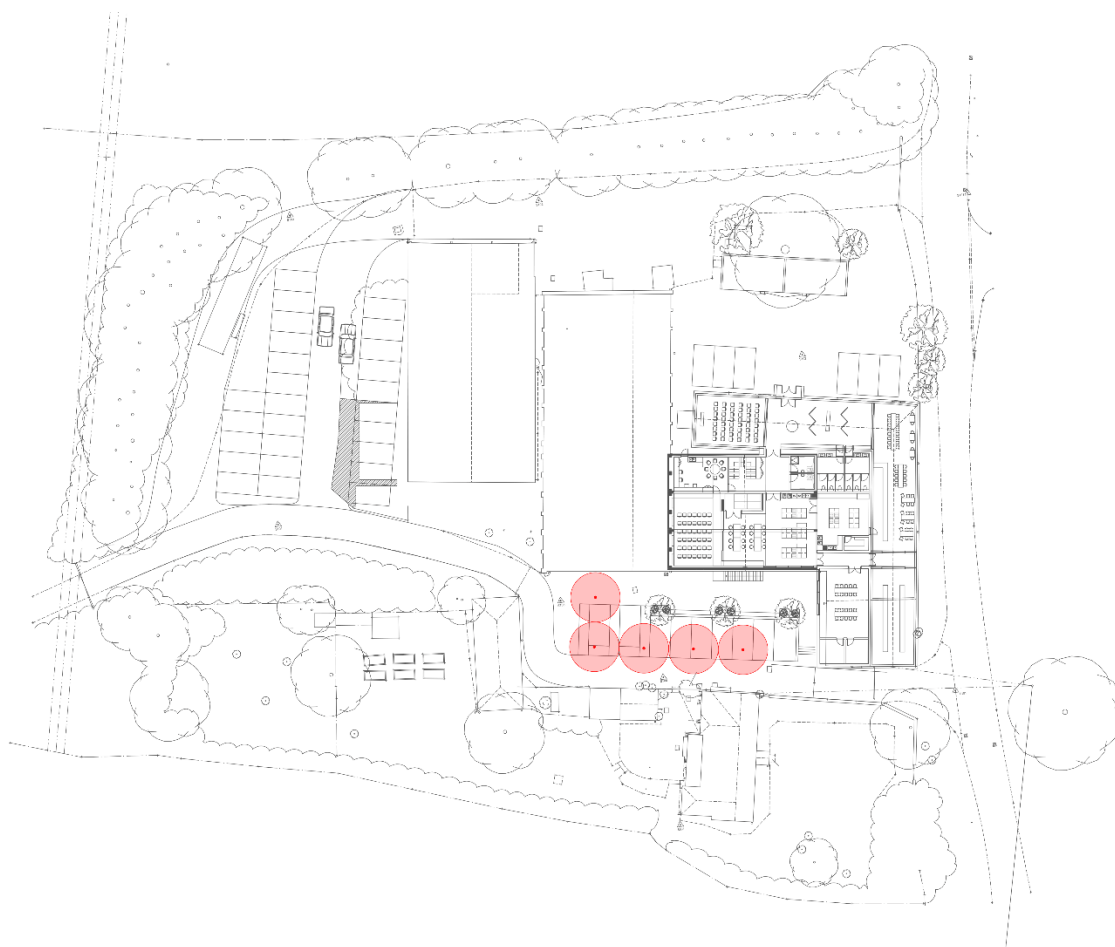


Figure 6: proposed borehole locations on site plan

- Electrical connections on site must be inspected prior to the installations of new GSHPs to ensure that they are of sufficient load capacity.

| Advantages                                                                                                                                                   | Disadvantages                                                                                                                                                             |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Generally, the lowest energy demand for heating in winter as gaining input energy from ground rather than air. No external fan units for less visual impact. | Number of boreholes and system performance is dependent on geological conditions. Boreholes and test boreholes are drilled at client's risk. High Capex compared to ASHP. |

## 4.4 Biomass (wood pellets)

**Suitability:** Biomass pellets offer a sustainable space heating solution. Made from compressed wood, they deliver consistent heat output and can be used in automated pellet boilers.. While requiring storage space and regular maintenance, modern systems offer high efficiency and low emissions. When sourced sustainably (e.g. pellets made

in the UK), biomass pellets provide a cost-effective, environmentally responsible heating option suited to spaces with consistent heating demands.

The downside is the chimney visual impact and regular maintenance. They also can not do cooling which is a need for the building.

It is thought running the whole building on log boiler would not be a manageable as you would need to do constant loading and burns.

| Advantages                                                              | Disadvantages                                          |
|-------------------------------------------------------------------------|--------------------------------------------------------|
| Low amount of carbon emissions produced.                                | Additional space is required on site for fuel storage. |
| Can reduce your grid connection substantially if your supply is limited |                                                        |
| Can be topped up with solar thermal easily                              |                                                        |

## 4.5 Hybrid: GSHP and Biomass (wood logs)

**Suitability:** Suitable. For this building with both heating and cooling demands, a **Ground Source Heat Pump (GSHP) and biomass (wood logs) hybrid system** can provide an efficient and sustainable solution.

- **GSHP:** Extracts heat from the ground, offering year-round heating and cooling with high efficiency. Ideal for steady, low-carbon heating and summer cooling but requires groundworks and electricity input.
- **Biomass (Wood Logs):** Provides high-temperature heating, complementing GSHP in peak winter demand. Requires manual fuel loading and a storage area but supports renewable energy goals and allows use of your own fuel.

This combination balances operational carbon savings, cost-effectiveness, and resilience, making it suitable for varied heating and cooling needs.

•

| Advantages                                                                                                   | Disadvantages                                                   |
|--------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|
| The log boiler allows use of your own forestry material without processing saving money and carbon           | The boiler must be fed once a day which requires manual labour. |
| Can reduce the need for a larger GSHP in winter for example, but allow the biomass to be shut off in summer. |                                                                 |
| Can be topped up with solar thermal easily                                                                   |                                                                 |

## 5 Building systems

### 5.1 Heat emitters – direct electric heating

Direct-electric panel radiators, convectors and coils can be positioned in much the same way as hydronic equivalents, however, there can be some greater flexibility in their placement and concealment due to the absence of bulky pipework.

### 5.2 Heat emitters – hydronic “wet” systems

Standard hydronic systems pump heating water around distribution pipework to emitters such as radiators, convectors, underfloor loops or coils.

### 5.3 Point-use water heaters

Hot water storage tanks have the advantage of holding an entire days' usage and provide reliable hot water at good pressure. For electrical solutions, a 'direct' cylinder is common, but a cheaper alternative is a point use (PU) heater.

By comparison, point-use direct-electrical heaters provide instant hot water at the time of need. They have no standing loss, but flow rates can be poor so are usually limited to use with low flow rate applications such as bathroom or kitchen taps.

Offices tend to have sporadic and intermittent use of hot water, and as such there may not be a demand for stored hot water. For this reason, we recommend the use of PU heaters for all DHW needs. PU heaters are also a cost-effective installation due to their simplicity and low upfront costs. They also save space by not needing a central hot water tank. Most importantly they allow for flexibility in design as they can be installed wherever have the need for hot water.

The primary drawback of point-use heaters is their high energy use compared with hot water generated by a heat pump. In addition, the high electrical demand means that wiring must be suitable, and the potential overall load must be taken into account during electrical design.

### 5.4 Other electrical systems

The electrical small power loading was based on the CIBSE rule of thumb for a similar building type and predicted usage. This includes items such as lighting, fridges, computers and other small devices.

Please note there may be equipment specific to the building or its tenants which may use additional electricity and could benefit from an integrated approach with the rest of the building. These have not been accounted for at this stage.

## 5.5 Other technologies

In addition to the above, there are several other technologies available which could generate heat and/or power. We haven't included these in our appraisal for the reasons below:

- **Heat networks:** the Scottish Government heat networks delivery plan suggests that neighbourhoods such as this would be a suitable area for a district heat network in a future programme. In some cases, community or local heat networks may also prove beneficial in the shorter term.
- **Fossil fuel boilers:** gas, oil, coal and wood boilers are direct-emissions systems, which under the current building regulations are not permitted in new developments.
- **Solar thermal:** the client wishes to incorporate solar photovoltaic on the building, meaning that the remain useful space available for an additional roof-mounted solar technology will be minimal.
- **Solar PV-T:** as with solar-thermal, the available space would likely be insufficient
- **Wind turbine:** the Energy Saving Trust wind speed predictor tool suggest a low mean wind speed at this location which precludes a commercially viable installation. We haven't considered wind power any further at this stage.
- **Hydro power:** There are no water courses in the immediate vicinity which would be suitable for a hydro scheme.

## 6 Environmental impact

The carbon cost associated with the project are shown in Figure 7. This includes all carbon emissions from the auxiliary heating fuel and electrical consumption. The carbon conversion factors used in the current compliance calculations are as per current UK greenhouse gas reporting conversion factors, however, we have used a grid intensity in line with the future grid decarbonising estimates.

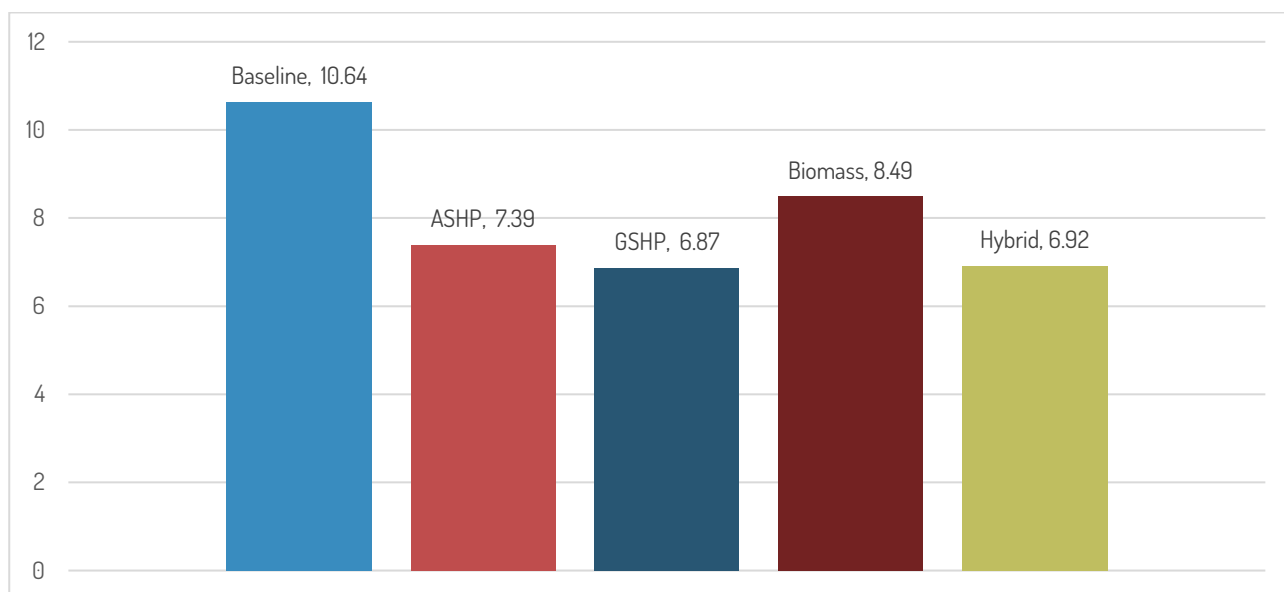


Figure 7 : carbon emissions for each option (tCO2e)

## 7 Planning and legislation requirements

If the project incorporates solar PV with a ground mounted system (not mounted on the roof), the project will require planning permission.

If using a heat pump, solar PV, or possibly thinking of electric vehicle (EV) charging then the project will require some approvals from the electricity grid Distribution Network Operator (DNO). It is the responsibility of the installer to do this. If there is a 'weak' local electricity supply, it may not be possible to connect a heat pump as the extra load could be too high for the network. Typically, a 3x 100A supply is connected for most buildings of this size. It is best to investigate this at an early stage if considering a heat pump, solar PV or electrical vehicle charging options.

Finally, an ASHP can generate noise which is calculated at the detailed design stage, however as a rule they should be a minimum 8-10 m from any noise sensitive areas or neighbouring properties, unless there are mitigating factors such as screens.

## 8 Next steps

### Equipment Selection

- Identification of preferred technology by client
- Development of full specification for technology and 'request for quote' sent out to shortlist of suppliers
- Review of quotes including assessment of cost variances, normalisation of tenders based on supplier discussions and responses and value engineering.
- Client to apply for any grants
- Re-visit the business case for the project taking into account latest outline costs and on-site fuel costs if required

### Detailed Design & Procurement

- Full measurement for pipe runs and fittings, plant room and flue & duct height calculations etc
- Drafting of detailed line diagrams and design specification for plant suitable for builders/ architects to conduct designs and construction drawings
- Development of detailed equipment schedule for plant and terminations/ overlaps identified. Design and specification for plant and equipment to ensure that all aspects of the project fully integrate.
- NB architectural, civil, and structural design package for building supplied by client/ client's architect

### Installation

- We can specify/ work with your own contractors
- Project support during construction phase as required; this is expected to comprise, meetings, site visits, telephone support, document & drawing revisions.

### Handover

- Project support during commissioning phase; this is expected to comprise acceptance testing of completed installation
- Airtightness testing and verification; likely to involve minimum 2 visits.
- Lodge final SBEM

## 9 Detailed summary tables

### 9.1 Heat demand

|                           | Baseline      | ASHP          | GSHP          | Biomass       | Hybrid        |
|---------------------------|---------------|---------------|---------------|---------------|---------------|
| Space heating (kWh)       | 34,736        | 34,736        | 34,736        | 34,736        | 34,736        |
| Space cooling (kWh)       | 16,521        | 16,521        | 16,521        | 16,521        | 16,521        |
| Hot water (kWh)           | 9,298         | 9,298         | 9,298         | 9,298         | 9,298         |
| <b>Total demand (kWh)</b> | <b>60,556</b> | <b>60,556</b> | <b>60,556</b> | <b>60,556</b> | <b>60,556</b> |

### 9.2 Heat input

|                          | Baseline      | ASHP          | GSHP          | Biomass       | Hybrid        |
|--------------------------|---------------|---------------|---------------|---------------|---------------|
| Assumed Heating SCoP     | 0.99          | 2.90          | 3.55          | 0.78          | 3.55          |
| Space heating (kWh)      | 35,087        | 11,978        | 9,785         | 44,534        | 22,882        |
| Space cooling (kWh)      | 16,521        | 5,163         | 4,291         | 6,608         | 4,291         |
| Hot water (kWh)          | 9,392         | 3,444         | 2,695         | 12,076        | 2,695         |
| <b>Total input (kWh)</b> | <b>61,001</b> | <b>20,585</b> | <b>16,771</b> | <b>63,218</b> | <b>29,868</b> |

### 9.3 Operating/running costs

|                           | Baseline       | ASHP           | GSHP           | Biomass        | Hybrid         |
|---------------------------|----------------|----------------|----------------|----------------|----------------|
| Standing charges          | £1,010         | £1,010         | £1,010         | £1,010         | £1,010         |
| Fuel                      | £19,971        | £9,243         | £7,530         | £8,572         | £7,006         |
| Other electrical          | £15,158        | £15,158        | £15,158        | £15,158        | £15,158        |
| Servicing                 | £-             | £-             | £-             | £-             | £-             |
| <b>Total annual costs</b> | <b>£36,139</b> | <b>£25,410</b> | <b>£23,698</b> | <b>£24,739</b> | <b>£23,174</b> |

### 9.4 Capital costs

|                    | Baseline | ASHP    | GSHP     | Biomass | Hybrid   |
|--------------------|----------|---------|----------|---------|----------|
| Heating units      | £21,000  | £77,000 | £170,000 | £60,500 | £122,000 |
| Cooling units      | £-       | £8,000  | £10,000  | £36,800 | £10,000  |
| Heating system     | £-       | £40,600 | £40,600  | £40,600 | £40,600  |
| Hot water system   | £6,000   | £6,000  | £6,000   | £6,000  | £6,000   |
| Ventilation system | £15,000  | £85,000 | £85,000  | £85,000 | £85,000  |

|                        |         |          |          |          |          |
|------------------------|---------|----------|----------|----------|----------|
| Solar & battery system | £-      | £-       | £-       | £-       | £-       |
| Additional systems     | £15,000 | £6,000   | £6,000   | £-       | £6,000   |
| Total capital costs    | £57,000 | £222,600 | £317,600 | £228,900 | £269,600 |

## 9.5 Summary

|                                                                   | Baseline | ASHP     | GSHP     | Biomass  | Hybrid   |
|-------------------------------------------------------------------|----------|----------|----------|----------|----------|
| Heating System Cost                                               | £21,000  | £117,600 | £211,025 | £101,053 | £162,302 |
| DHW System Cost                                                   | £6,000   | £6,000   | £6,000   | £6,000   | £6,000   |
| Ventilation System Cost                                           | £15,000  | £85,000  | £85,000  | £85,000  | £85,000  |
| Additional Costs                                                  | £15,000  | £6,000   | £6,000   | £-       | £6,000   |
| Total Capital Costs                                               | £61,200  | £248,260 | £353,228 | £255,761 | £299,632 |
| Net capital costs                                                 | £61,200  | £248,000 | £353,000 | £256,000 | £300,000 |
| Heating & Hot Water Running Costs                                 | £19,971  | £9,243   | £7,530   | £8,572   | £7,006   |
| Electricity Running Costs                                         | £15,158  | £15,158  | £15,158  | £15,158  | £15,158  |
| Total Annual Running Costs (Inc servicing, standing charges, etc) | £36,100  | £25,400  | £23,700  | £24,700  | £23,200  |
| Net annual costs                                                  | £36,100  | £25,400  | £23,700  | £24,700  | £23,200  |
| Cumulative costs 5 years                                          | £254,000 | £384,000 | £480,000 | £388,000 | £423,000 |
| Cumulative costs 10 years                                         | £470,000 | £535,000 | £621,000 | £535,000 | £562,000 |
| Cost parity (years)                                               | n/a      | 16       | 20       | 16       | 17       |
| Annual emissions (tCO2e)                                          | 10.64    | 7.39     | 6.87     | 8.49     | 6.92     |

## 10 Terms and abbreviations

|              |                                                      |
|--------------|------------------------------------------------------|
| <b>ACD</b>   | Accredited Construction Details                      |
| <b>ASHP</b>  | Air Source Heat Pump                                 |
| <b>BER</b>   | Building Emissions Rate                              |
| <b>CIBSE</b> | Chartered Institution of Building Services Engineers |
| <b>DHW</b>   | Domestic Hot Water                                   |
| <b>DoT</b>   | Design Outdoor Temperature                           |
| <b>EPC</b>   | Energy Performance Certificate                       |
| <b>ExAHP</b> | Exhaust Air Heat Pump                                |

|                |                                            |
|----------------|--------------------------------------------|
| <b>GSHP</b>    | Ground Source Heat Pump                    |
| <b>HP</b>      | Heat Pump                                  |
| <b>HVAC</b>    | Heating, ventilation and air-conditioning  |
| <b>IR</b>      | Infra-Red                                  |
| <b>MVHR</b>    | Mechanical Ventilation Heat Recovery       |
| <b>kW</b>      | kilowatt                                   |
| <b>kWh</b>     | kilowatt hour                              |
| <b>NV</b>      | Natural Ventilation                        |
| <b>PV</b>      | Photovoltaic (Solar)                       |
| <b>SAP</b>     | Standard Assessment Procedure              |
| <b>SBEM</b>    | Simplified Building Energy Model           |
| <b>SCOP</b>    | Seasonal Coefficient of Performance        |
| <b>TER</b>     | Target Emissions Rate                      |
| <b>UFH</b>     | Underfloor Heating                         |
| <b>U-Value</b> | Thermal Transmittance (W/m <sup>2</sup> K) |

## 11 Assumptions

The performance of microgeneration systems is impossible to predict with certainty due to the variability of the climate and its subsequent effect on both heat supply and demand. This estimate is given as guidance only and should not be considered as a guarantee.

Domestic rates are updated regularly from the Energy Saving Trust website. Commercial rates are as supplied, or with best available data such as those from the Uswitch for Business comparison website.

All costs exclude VAT.

|                                                            |             |
|------------------------------------------------------------|-------------|
| <b>Electricity unit rate (£/kWh)</b>                       | £0.449      |
| <b>Wood pellets unit rate (£/kWh)</b>                      | £0.099      |
| <b>Wood logs unit rate (£/kWh)</b>                         | £0.050      |
| <b>Inflation used/ CPI</b>                                 | 2.22%       |
| <b>Standing charge - Electricity (£/year)</b>              | £347        |
| <b>Standing charge - Gas (£/year)</b>                      | £243        |
| <b>Electricity emission rate (CO<sub>2</sub>e kg/kWh)</b>  | 0.136       |
| <b>Wood pellets emission rate (CO<sub>2</sub>e kg/kWh)</b> | 0.053       |
| <b>Wood logs emission rate (CO<sub>2</sub>e kg/kWh)</b>    | 0.028       |
| <b>Post code</b>                                           | SG4 7DR     |
| <b>Rock type</b>                                           | Limestone   |
| <b>Soil type</b>                                           | Gravel, dry |

# Appendix 1 – Outline ventilation

## Kitchen Ventilation

The aim of any ventilation/extraction is to ensure that no nuisance, disturbance or loss of amity is caused by odour, fumes, food droplets or noise, to nearby properties. Enquiries should be made to the Local Authority Planning Department regarding this matter. Given the location of Irongate Farm in Weston, Hertfordshire, the regulations may be somewhat more relaxed than they would be for an urban setting. Detailed design of the kitchen ventilation system will be based on installed equipment.

Best Practice for Design and Operation of Commercial Kitchen Ventilation Systems:

### Performance Requirement

#### Minimum Ventilation Rates

- An internal ambient air temperature of 28°C Maximum
- Maximum humidity levels of 70%
- Internal noise level should be between NR40-NR50
- Dedicated make up air systems to be approximately 85% of the extract flow rate
- Minimum air change rate of 40 per hour (based on canopy and general room extraction)
- Exact flow rates for a commercial kitchen to be calculated using the thermal convection method based on installed equipment

#### Minimum Requirement for Canopy

#### Velocity Requirements:

- Light loading – 0.25m/s (steaming ovens, boiling pans, bain maries and stock pots)
- Medium Loading – 0.35m/s (deep fat fryers, solid and open top ranges and griddles)
- Heavy Loading – 0.5m/s (chargrills, specialist broiler units)

#### Sizing

- Plan dimension of the canopy shall exceed the plan dimensions of the catering equipment by a minimum of 250mm on each free side.
- This should be increased to 600mm in front of combination steaming ovens.

#### Materials

- 430-grade Stainless Steel

#### Grease Separation

- Grease shall be extracted by separators

#### Duct Work

- All duct work shall be Low Pressure Class 'A' and be to DW/144

#### Velocities

|                    | Supply (m/s) | Extract (m/s) | Noise (dBA at1m) |
|--------------------|--------------|---------------|------------------|
| <b>Main Runs</b>   | 6.8          | 6.9           | 35               |
| <b>Branch Runs</b> | 4-6          | 5-7           | 35               |
| <b>Spigots</b>     | 3-5          | 5-7           | 35               |
| <b>Terminals</b>   | 4            | 4             | 35               |

- Where it is not possible to immediately discharge the captured air, fire rated ductwork may be required.

#### Minimum Requirements for Fans

- Backward curved centrifugal, mixed flow or axial flow impellers are preferred as they provide a more stable airstream and are more easily maintained.
- Metal impellers shall be used.
- Sufficient space for regular cleaning and maintenance.
- Fans serving canopies above solid fuel burning appliances should have motor out with the airstream.

#### Minimum Requirements for Odour Control

##### Objectives

- Premises covered by Planning Conditions restricting the impact of odour shall be designed to prevent harm to the amenity.
- Two phases of contamination should be considered – particulate and odour.

#### Discharge Stack

- Discharge the extracted air not less than 1m above the roof ridge of any building withing 15m of the vent serving the commercial kitchen.
- If non-compliant in this regard, higher level of odour control may be necessary.

#### Minimum Requirements for Noise Control

- Premises covered by Planning Conditions restricting the impact of noise, the system shall be designed to prevent an acoustic impact on the external environment and harm to the amenity
- Noise exposure of kitchen staff meets Control of Noise at Work Regulations 2005.

To achieve these objectives the noise control system shall include

- Control of noise at source
- Control of noise to the environment by taking acoustic considerations into account within duct, grille and termination design.
- Suitable in-line attenuation if required.

## Static Kitchen

Ductwork Sizing

Extract

$$29\text{m}^2 \times 3.6\text{m} \times 24\text{ACH}^{-1} = 2505.6\text{m}^3/\text{hr} = 0.7\text{m}^3/\text{s} \text{ at } 6\text{m/s} = \varnothing 400$$

Supply Make Up Air

$$0.7\text{m}^3/\text{s} \times 0.85 = 0.6\text{m}^3/\text{s} = \varnothing 350$$

## Dynamic Kitchen

Option 1

Mobile Re-circulation Ductless Canopy Unit

The commercial grade filters can be adapted to suit different food menus, even light frying of foods. The extraction kit offers an air recirculation system. The filters are all standard sizes and can be specified with higher or lower micron filtration to suit food offering as well as more aggressive HEPA filters and carbon cells to remove all elements of smell.

Limitations

- Can only be used with electric or induction cooking equipment.
- The system will not remove heat, or moisture.

Option 2

Autonomous Mobile Cooking Station

Mobile cooking stations which create an air curtain which contains fumes, smoke and heat within the cooking area. The smoke and odour are steered toward an integrated recycling unit holding cyclonic filters which removing odours and grease. Fan speeds can be controlled and enable maximum efficiency.

Limitations

- Can only be used with electric or induction cooking equipment.
- The system will not remove heat, or moisture.

Both options would require extract and fresh air supply ventilation which would be supplied through the MVHR unit.

## Heat Recovery Air Handling Unit

A heat recovery air handling unit (AHU) is an HVAC system that improves energy efficiency by reclaiming heat from exhaust air and using it to pre-heat incoming fresh air, reducing the energy needed for heating or cooling.

- Exhaust Air: Stale, warm or cool air is extracted from the building.

- **Heat Recovery:** A heat exchanger (like a thermal wheel or plate heat exchanger) transfers heat from the exhaust air to the incoming fresh air.
- **Pre-conditioned Air:** The fresh air, now pre-heated, is then circulated through the building's ventilation system.

With balanced supply and extract, this process reduces the energy required to heat the incoming air, leading to significant energy savings and improved efficiency.

#### Ventilation Rates

Offices 10l/s/person, Lecture Theatre 10 l/s/person, WC 5 ACH<sup>-1</sup>

Supply & Extract in the region of 1700 l/s = 7000 Ducts from AHU

#### Plant Area

Ventilation plant to be mounted externally on flat roof.

Approx Size of Unit 3000Lx2300Hx2000W

Approx Weight of Unit 1500kg

#### Indicative Noise Rating of AHU

| Frequency band      | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k |    | All |       |
|---------------------|----|-----|-----|-----|----|----|----|----|----|-----|-------|
| To supply air duct  | 75 | 70  | 71  | 73  | 70 | 68 | 66 | 66 | dB | 76  | dB(A) |
| To outdoor air duct | 71 | 69  | 68  | 55  | 47 | 44 | 40 | 43 | dB | 61  | dB(A) |
| To extract air duct | 70 | 69  | 70  | 58  | 50 | 48 | 47 | 50 | dB | 63  | dB(A) |
| To exhaust air duct | 75 | 70  | 72  | 74  | 71 | 70 | 68 | 68 | dB | 77  | dB(A) |
| To surroundings     | 67 | 59  | 52  | 56  | 41 | 40 | 37 | 40 | dB | 55  | dB(A) |

# Appendix 1 – Outline kitchen and odour ventilation

As part of the proposed development for Groundschool at Irongate Farm, a commercial kitchen is anticipated to support educational, hospitality, and community functions. A robust kitchen extraction system is essential to manage indoor air quality, fire safety, odour, and acoustic performance. This addendum provides an outline assessment of expected noise and smell impacts, with recommended mitigation measures and system design best practices aligned with industry guidance (including DEFRA, CIBSE, and BESA).

---

## 1. Design requirements for the Kitchen Extraction System

The kitchen extraction system must:

Extract cooking fumes, steam, and heat from the kitchen.

Filter and treat odours and grease before discharging air externally.

Limit internal noise for users and control external sound emissions.

Meet planning and environmental health requirements, particularly in the rural or low-background-noise locations such as Irongate Farm.

---

## 2. Noise Impact and Mitigation

### 2.1 Sources of Noise

- Kitchen ventilation systems typically generate sound from:
- Mechanical fan units, especially high-speed centrifugal fans.
- Air movement in ductwork, particularly at high flow velocities.
- Vibrations from poorly isolated equipment.
- Discharge noise at termination points (e.g., louvres or cowls).

### 2.2 Design Strategies to Reduce Noise

To reduce the acoustic impact, we recommend the following design strategies:

- Low-noise fan selection: Use belt-driven or direct-drive centrifugal fans with acoustic ratings below 45 dB(A) at 3 m. Variable-speed drives (VSDs) can reduce output during off-peak hours.
- Acoustic duct linings: Incorporate internal linings or silencers (attenuators) in ductwork to absorb sound energy.
- Flexible anti-vibration mounts: Prevent mechanical vibration transmission to the building structure.

- Locate discharge points >10 m from habitable or noise-sensitive spaces, or reduce this to 8 m with barriers or acoustic louvres.

---

### 3. Odour and Air Quality Management

Cooking emissions (including oil vapours, particulates, and volatile organic compounds) require controlled extraction and filtration to avoid odour nuisance, grease buildup, or environmental harm.

#### 3.1 Typical Pollutants

Grease and particulates – from frying and grilling.

Steam and moisture – from boiling, washing, etc.

Odour compounds – especially from aromatic or spiced dishes.

#### 3.2 Recommended Filtration Strategy

##### **Passive Filters**

The passive filter system will consist of bag and HEPA filters and be housed within a galvanised steel casing that allows for side withdrawal of the filters.

Bag filter:

- The bag filter media will be 100% polyester synthetic
- The bag filter media will be nontoxic and non-irritant
- The bag filter will be fire rated CP413
- The filter media will be fitted into a galvanised steel header frame
- Corrosive resistant

HEPA filter:

- The High Efficiency Particulate Air (HEPA) Filter will have a minimum efficiency of 95%
- The media will be glass fibre paper mini-pleated
- The sealant will be cold moulded polyurethane
- The frame will be galvanised or stainless steel
- The gasket will be PU foam

##### **Activated Carbon Filters**

- The carbon filter panels will be bonded panels that hold the activated carbon granules in a rigid biscuit.

- The biscuit will be encapsulated in a carbon impregnated cloth, which will prevent any leakage of granules or powder.
- The grade of carbon will be AC207
- Carbon filters will be sized to have a dwell time of between 0.4s to 0.8s.

## Ultraviolet Air Treatment

Inline UV:

- The in-airstream UV system will only be used in a system following an Electrostatic Precipitator, otherwise lamps will become contaminated and rendered ineffective.
- Construction will be of steel
- There will be light sealing either side of the unit, to prevent direct eye contact with UV light
- Safety interlock will be standard to the door when opening
- 185 or 254nm lamps will be fitted
- Volt-free contact will be able to be made to demonstrate a fault

All filters should be accessible for inspection, replacement, and maintenance to prevent performance deterioration.

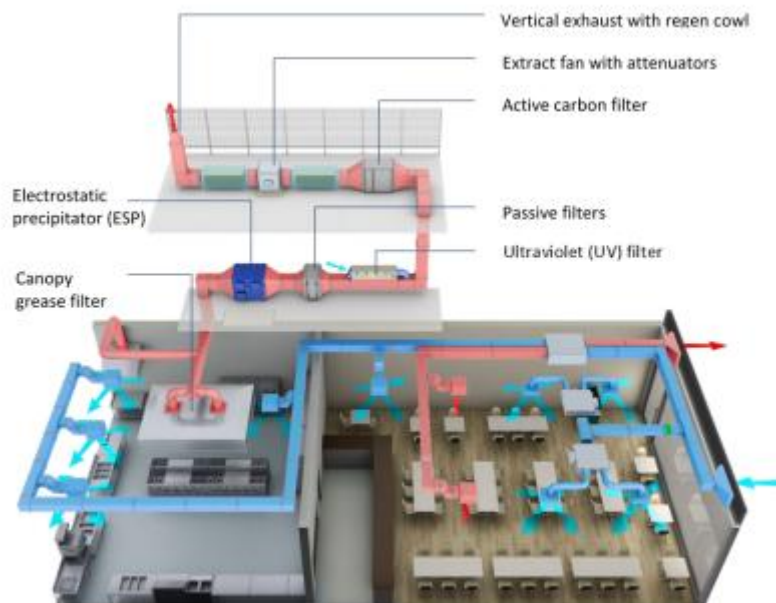


Diagram 1: Filtration System Schematic

#### 4. Discharge Design and Environmental Control

Effective discharge of filtered air is crucial to dispersing any residual odours or pollutants and to maintaining environmental compliance.

##### 4.1 Discharge Parameters

Discharge height: Minimum 1 m above the ridge or eaves of the nearest building.

Exit velocity:  $\geq 15$  m/s to promote vertical dispersion.

Stack material: Galvanised or stainless steel to prevent corrosion.

Discharge location: Avoid prevailing wind directions towards neighbouring areas.

A vertical discharge stack is preferred over side-mounted louvres, as it offers better dispersion and reduced odour risk.

---

#### 5. Summary of Recommendations

##### Design Element Mitigation Strategy

Noise Control    Low-noise fans, silencers, anti-vibration mounts, discharge  $>10$  m from sensitive receptors

Odour Control    3-stage filtration: grease, fine particulate, activated carbon, with optional UV

Discharge        Vertical, high-velocity, roof-mounted stack  $\geq 1$  m above eaves

Maintenance    Scheduled inspection and filter replacement to maintain performance

Regulation       Compliance with DEFRA, CIBSE, and BS 4142 guidelines

We confirm that that all systems meet Part F of the Building Regulations (Ventilation).

## 12 Disclaimer of liability

This report is prepared by us, Lùths Services Ltd, for you, the Client to assist the Building Services Engineering. It has been prepared to provide general information to assist the Client in its decision, and to outline some of the issues, which should be considered by the Client. It is not a substitute for the Client's own investigation and analysis. No final decision should be taken based on the content of this report alone. This report should not be copied, shown to, or relied upon by any third parties without our express prior written consent. Nothing in this report is intended to or shall be deemed to create any right or benefit in favour of a third party. In compiling this report, we have relied on information supplied to us by the Client and by third parties. We accept no Liability for the completeness and/or veracity of the information supplied to us, nor for our conclusions or recommendations based on such information should it prove not to be complete or true. We have been asked to comment on Building Services only, in accordance with the Client's instructions as to the scope of this report. We have not commented on any other matter and exclude all Liability for any matters out with the said scope of this report. If you feel there are any matters on which you require additional or more detailed advice, we shall be glad to assist. We hereby disclaim any and all liability for any loss (including without limitation consequential or economic loss), injury, damage, costs, and expenses whatsoever ("Liability") incurred directly or indirectly by any person as a result of any person relying on this report except as expressly provided for above. In any case, our total aggregate Liability in connection with the provision of this report (whether by contract, under delict or tort, by statute or otherwise) shall be limited to the aggregate of fees (excluding any VAT) actually paid by the Client to us for provision of this report/ service. The performance of microgeneration systems is impossible to predict with certainty due to the variability of the climate and its subsequent effect on both heat supply and demand. This estimate is given as guidance only and should not be considered as a guarantee.