RIDGE

**BICESTER HERITAGE**
**NEW TECHNICAL SITE**

**ENERGY STRATEGY**
November 2018

# NEW TECHNICAL SITE

# ENERGY STRATEGY

November 2018

## Prepared for

Bicester Heritage
Buckingham Road
Bicester
Oxfordshire
OX27 8AL


## Prepared by

Ridge and Partners LLP
The Cowyards
Blenheim Park
Oxford Road
Woodstock
OX20 1QR

Tel: 01993815000

## Contact

Felipe Castro
Senior Building Services Engineer
CIBSE Low Carbon Consultant
fcastro@ridge.co.uk
07775542307

## VERSION CONTROL

Project name: Bicester Heritage New Technical Site
Project number: 5002855
Document number: 5002855-RDG-XX-XX-DOC-ME-9900

| VERSION | DATE | DESCRIPTION | CREATED BY | REVIEWED BY |
|---|---|---|---|---|
| - | 23/11/2018 | For Planning | FC | PW |
| A | 26/11/2018 | For Planning, Additional references to site plan updated. | FC | PW |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

# CONTENTS

# EXECUTIVE SUMMARY

Ridge and Partners LLP were appointed by Bicester Heritage to provide low carbon and energy design consultancy advice for the proposed new Technical Units at the Bicester Heritage site,

This report presents the energy assessment carried out for the proposed technical units. It followed the three-stage approach described by the Greater London Authorities (GLA) Energy Hierarchy.

The following design measures are recommended for inclusion in the design development of the proposed New Technical Units at Bicester Heritage:

Be Lean measures:

- Reduced heating demand - achieved by improved U-values, low air permeability and glazing optimization. These measures will reduce the heat loss through the building fabric and uncontrolled ventilation.
- Ventilation – the use of natural ventilation where possible.

Be Clean measures:

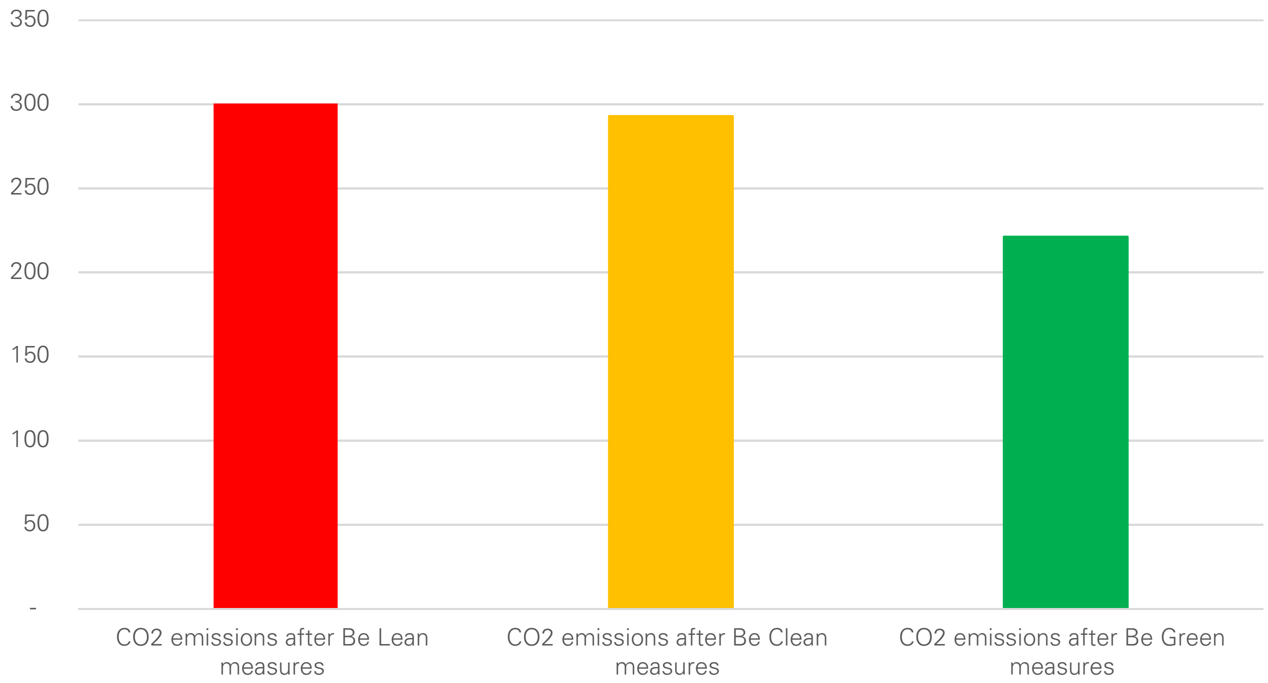
- Provide high efficiency internal and external lighting throughout the proposed units.
- Develop an efficient lighting control strategy which includes photoelectric (daylight) sensing and occupancy presence detection were applicable. External lighting is to be linked to daylight sensors and a timer only to provide lighting when it is required.
- Use variable speed drives on pumps and fans where applicable.
- All duct-work and pipework to be suitably insulated.
- Develop a metering and sub-metering building services strategy to monitor energy used within all proposed units.
- Where applicable use highly efficient heat recovery ventilation system.
- Due to the low DHW demand anticipated within the proposed units, consider the use of instantaneous DHW systems to reduce system standby/storage losses.
- Ensure that energy efficient white goods are installed within the proposed Technical Units.

Be Green Measures:

The following LZC technologies are recommended for the proposed building:
Our recommended approach is to outline the following technologies for each technical unit Fit-out.

| LZC TECHNOLOGY | SUITABILITY |
|---|---|
| Air Source Heat Pumps | Suitable<br>Recommended. |
| Photovoltaic Panels | Feasible<br>Recommended<br>Note that further advice and consultation with the Civil Aviation Authority (CAA) is required to assess the panels implementation. |

The estimated $CO_2$ savings using Air Source Heat Pump technologies in addition to the Be Lean and Be Clean measures resulted in a cumulative saving of approximately 41%. The graph below illustrates the CO2 savings at each stage of the Energy Hierarchy.




*Graph 1 - Energy Hierarchy carbon savings*

# 1. INTRODUCTION

## 1.1. General

Ridge and Partners LLP were appointed by Bicester Heritage to provide low carbon and energy design consultancy advice for the proposed new Technical Units at the Bicester Heritage site,

This report outlines the energy strategy developed in line with the Cherwell Local Plan ESD Polices 1 to 5.

- ESD 1 – Mitigating and Adapting to Climate Change
- ESD 2 – Energy Hierarchy
- ESD 3 – Sustainable Construction
- ESD 4 – Decentralised Energy Systems
- ESD 5 – Renewable energy

The analysis undertaken was based on a series of energy simulations using published energy benchmarks and Simplified Building Energy Model (SBEM) methodology to estimate the likely energy and $CO_2$ performance of the proposed buildings.

## 1.2. Energy modelling context

The report presents the energy assessment carried out for the proposed technical units. It followed the three-stage approach described by the Greater London Authorities (GLA) Energy Hierarchy and the Chartered Institute of Building Services Engineers' (CIBSE) Low carbon design principles to reduce the buildings carbon dioxide ($CO_2$) emissions (described in Table 1. Figure 1 below illustrates the critical path followed)

| BE LEAN | BE CLEAN | BE GREEN |
|---|---|---|
| Reduce the building's energy demand through the implementation of appropriate "passive design measures" | Meet the buildings' reduced energy demand in the most energy efficient way possible through the implementation of "active design measures" that aim to improve the energy efficiency of mechanical and electrical (M&E) services. | Reduce the buildings resulting $CO_2$ emissions through the implementation of renewable energy technologies. |

*Table 1 – Energy Hierarchy*

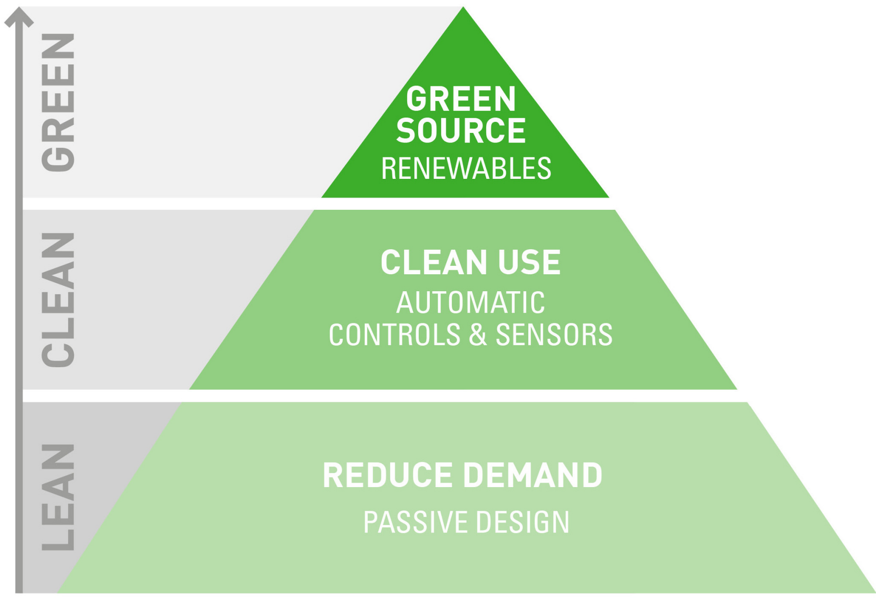



*Figure 1 – Energy Hierarchy*

## 1.3. Project Context

The development consists of 8Nr new units comprising light industrial, general industrial, distribution/storage, ancillary offices, storage, display and sales areas (The proposal are to be built on a Shell & Core Basis) Figure 2 and Table 2 below illustrates and present the proposed site plan and accommodation schedule of the Technical Units. [Please refer to 5002855 RDG XX ST PL A 0003 H for the full-scale drawing].

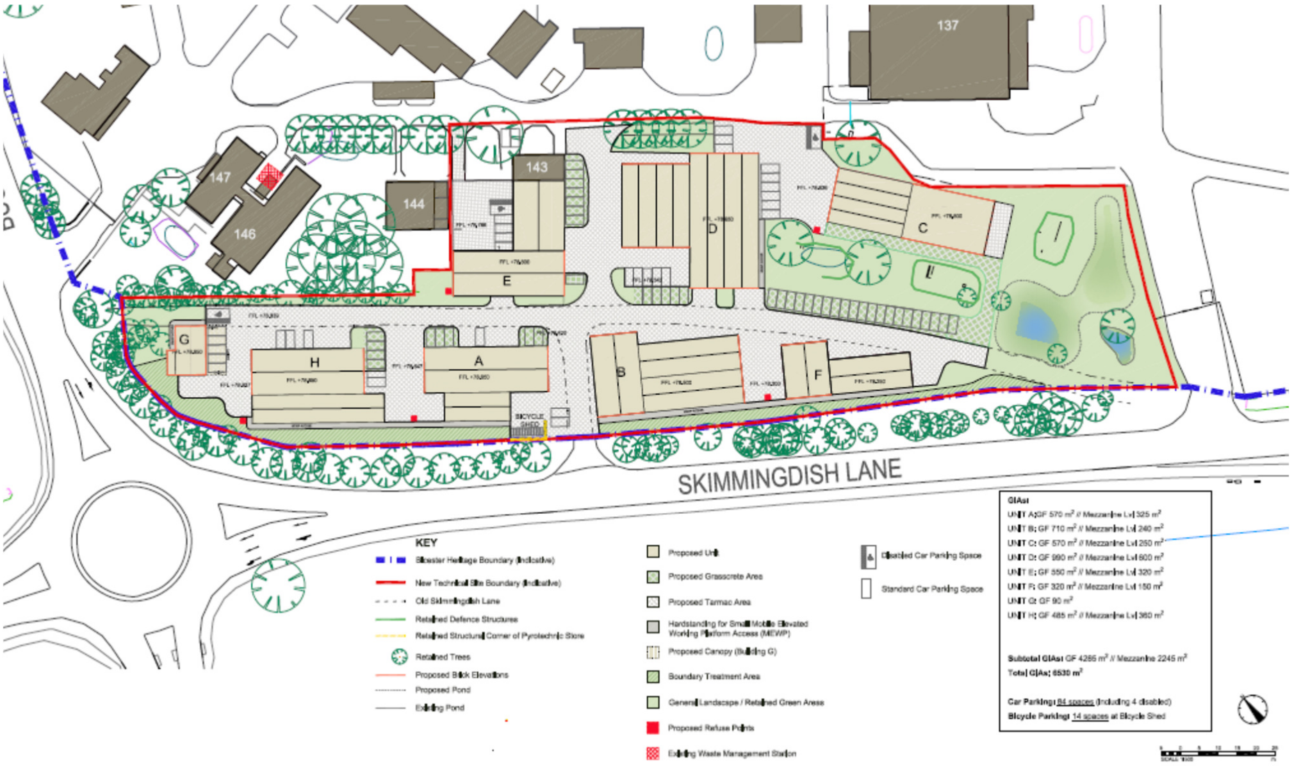



*Figure 2 – New Technical Units proposed site*

| UNITS | GF AREA (M²) WORKSHOPS | FF AREA (M²) SPECULATIVE ANCILIARY OFFICES | TOTAL AREA (M²) |
|---|---|---|---|
| Unit A - 145 | 570 | 325 | 895 |
| Unit B - 140 | 710 | 240 | 950 |
| Unit C - 138 | 570 | 250 | 820 |
| Unit D - 141 | 990 | 600 | 1,590 |
| Unit E - 142 | 550 | 320 | 870 |
| Unit F - 139 | 320 | 150 | 470 |
| Unit G - 149 | 90 | - | 90 |
| Unit H - 148 | 485 | 360 | 845 |

*Table 2 – New Technical Units accommodation schedule*

# 2. LOW CARBON DESIGN PRINCIPLES

This section outlines the methodology used to assess the proposed developments estimated annual energy consumption and resulting regulated and unregulated $CO_2$ emissions.

## 2.1. Energy assessment methodology

The following steps describe the method used to assess the energy reduction potential the "Be Lean, Be Clean and Be Green" framework offer to the energy strategy for the new technical units at Bicester Heritage.

- Use BSRIA and CIBSE energy benchmarks to estimate the buildings (and sites) annual energy consumption in kWh. This method used the gross internal areas of the proposed development (refer to Table 2 above)
- Estimate the buildings' energy end use (Space Heating, Lighting, Domestic Hot Water (DHW), etc). using a SBEM model of Unit B 140. Apply the end use proportions to the overall site.
- Estimate the energy contribution of the proposed "Passive (be Lean) and Active (be Clean)" measures
- Assess the technical suitability and viability of Low and Zero Carbon Technologies (LZCs) technologies.
- Estimate the potential energy and $CO_2$ contribution of the feasible LZCs technologies.
- Quantify and present the energy assessment carried out following the steps above.

To complete the assessment described above the following information was used:

| ENERGY BENCHMARKS | ELECTRICITY | FOSSIL FUEL THERMAL |
|---|---|---|
| Workshops | 35 (kWh/m$^2$) | 180 (kWh/m$^2$) |
| Offices | 95 (kWh/m$^2$) | 120 (kWh/m$^2$) |

*Table 3 – BSIRA/CIBSE Energy Benchmarks*

| CARBON DIOXIDE EMISSIONS FACTORS | |
|---|---|
| Grid supplied Electricity | 0.519 kg$CO_2$/kWh |
| Natural Gas | 0.216 kg$CO_2$/kWh |

*Table 4 – Carbon factors [source: SBEM and NCM Non-domestic Buildings 2013]*

## 2.2. Design Measures

This section focuses on the low carbon design principles where the building's energy demand can be reduced to create an energy efficient design solution. The implications in relation to Part L 2013 of the Building Regulations are explored, with reference to the technical and functional feasibility of various energy efficiency measures.

### 2.2.1. Be Lean

The following section describes the passive design principles explored and recommended for the new Technical Site and Bicester Heritage.

#### 2.2.1.1. External fabric

Reduced U-values and air permeability are proposed to exceed the minimum requirements of Part L2A and are summarised in the table below. This low carbon design measure aimed to reduce the heat demand through the external fabric of the building reducing fabric and uncontrolled ventilation heat losses. In addition to the above, the solar transmittance of all glazing units (G-value) needs to be carefully considered to limit the solar gains and reduce overheating risk.

| ELEMENT | PART L2A DESIGN LIMIT | PROPOSED PERFORMANCE |
|---|---|---|
| External Walls | 0.35 W/m²K | 0.28 W/m²K |
| Ground contact floor | 0.25 W/m²K | 0.25 W/m²K |
| Roof | 0.25 W/m²K | 0.13 W/m²K |
| Windows | 2.20 W/m²K | 1.80 W/m²K |
| Vehicle access or similar large doors | 1.50 W/m²K | 1.50 W/m²K |

*Table 5 – External fabric thermal performance*

| BUILDINGS OVERALL AIR PERMEABILTY | |
|---|---|
| RIBA Stage 2 Target | 5.00m³/(h.m²) at 50 Pa |

*Table 6 – Target air permeability for the new Technical Units at Bicester Heritage.*

### 2.2.1.2. Daylight

The proposed buildings have developed energy efficient facades and roofs (proportions of glazing and rooflights have been incorporated) which aim to provide adequate levels of daylight to reduce the use of artificial lighting whilst limiting direct solar gain to reduce overheating risk within the spaces

## 2.2.2. Natural Ventilation

Provide natural ventilation where applicable through operable windows and roof-lights. Special consideration with regards to external factors such as noise and pollution is required.

## 2.2.3. Be Clean

The energy consumption of the development will be further reduced by the incorporation of active design measures which aim to meet the reduced energy demand achieved by implementing the design measures described in the previous section. Due to the speculative nature of this project at this stage we recommended that all potential tenants developed their Fit-out surpassing the requirements set by Part L of the building regulations in the Building Services compliance guide for non-domestic buildings. Special consideration should be give to the following:

- Provide high efficiency internal and external lighting throughout the proposed units.
- Develop an efficient lighting control strategy which includes photoelectric (daylight) sensing and occupancy presence detection were applicable. External lighting is to be linked to daylight sensors and a timer only to provide lighting when it is required.
- Use variable speed drives on pumps and fans where applicable.
- All duct-work and pipework to be suitably insulated.
- Develop a metering and sub-metering building services strategy to monitor energy used within all proposed units.
- Where applicable use highly efficient heat recovery ventilation system.
- Due to the low DHW demand anticipated within the proposed units, consider the use of instantaneous DHW systems to reduce system standby/storage losses.
- Ensure that energy efficient white goods are installed within the proposed Technical Units.

### 2.2.4. Be Green

The following section presents a summary of the exercise carried out to consider the technical, physical and financial feasibility and viability of LZC technologies contribution energy and reduce $CO_2$ emissions to the proposed development.

## 2.3. LZC Feasibility study

The exercise aimed to identify the most suitable LZC technology for the development. Ten of the twelve LZC technologies (as shown in the Table 7 below) were investigated as part of this exercise except for tidal and wave power, as there are no suitable water sources near the development to make these technologies feasible. The remaining technologies reviewed will include the following and they were classed as technically suitable, feasible and not feasible. Please refer to appendix one below for the full LZC feasibility study.

| LZC TECHNOLOGY | APPLICABILITY | FEASIBILITY |
|---|---|---|
| **Solar Technologies** | | |
| Solar Photovoltaics (PV) Panels | There is sufficient roof space and the orientation on some of the buildings are is ideal for the installation of PV panels. This system provides true renewable energy and at this stage the carbon savings are beneficial.<br>Special consideration must be provided due to the location of the proposed site. Specialist consultation is required to assess the technical viability of PV panels being installed within an airfield.<br>At this stage this technology is feasible pending further specialist input.<br>Further health and safety considerations are to be reviewed with the civil aviation authority(CAA) | Feasible |
| Solar Thermal DHW heating panels | Since there is not an anticipated DHW constant demand on the proposed units to make the system work efficiently this system is not recommended for implementation. | Not Feasible |
| **Wind Technologies** | | |
| Wind Turbines | There is insufficient space available on the site to accommodate this technology. | Not Feasible |
| **Bio-fuel technology** | | |
| Biomass Boilers | Space requirements, fuel delivery and fire risk decrease feasibility.<br>At this stage the technology does not offer the flexibility required. The intention is that all proposed Technical Units be served individually therefore each unit will require additional external space to accommodate fuel storage facilities.<br>This technology is not recommended at this stage. | Not Feasible |

| LZC TECHNOLOGY | APPLICABILITY | FEASIBILITY |
|---|---|---|
| **Low Carbon technologies** | | |
| Community / District Heating | There are no local heat networks within the vicinity of the site.<br>At an early stage of design creating an energy centre for the proposed Technical Units was considered and discarded. | Not Feasible |
| Combined Heat and Power (CHP) | There is no constant heat demand to make this technology suitable | Not Feasible |
| Fuel Cells | Undeveloped technology with relatively untested infrastructure for fuel delivery. | Not Feasible |
| Air to air heat pumps (Electric / Gas) | ASHP is a suitable technology since they can provide low carbon heating and cooling and works well with PVs. | Suitable |
| Ground to air/water heat pumps (Electric) | Technically may be feasible but lack of space and budget constraints decrease the feasibility. It has to be noted that the technology is feasible at initial construction stage, but it is not viable for the proposed site due to the shell and core approach proposed. | Feasible |
| Water to air/water heat pumps (Electric) | No water source nearby. | Not Feasible |
| **Water Energy** | | |
| Hydroelectric / Tidal / Wave power | No water source nearby. | Not Feasible |

*Table 7 – LZC Feasibility Study summary*

## 2.3.1. LZC Feasibility summary

Our recommended approach is to outline the following technologies for each technical unit Fit-out.

| LZC TECHNOLOGY | SUITABILITY |
|---|---|
| Air Source Heat Pumps | Suitable<br>Recommended. |
| Photovoltaic Panels | Feasible<br>Recommended (please note that further advice and consultation with the CAA is required to assess the panels implementation. |

# 3. ENERGY ASSESSMENT

This section presents the estimated annual energy and $CO_2$ performance for the proposed site.

## 3.1. Annual energy consumption

Table 8 below shows the annual energy consumption of the proposed units which was based on the accommodations schedule and energy benchmarks presented in sections 1.3 and 2.1 above (refer to Table 2 and Table 3 above)

| UNITS | WORKSHOPS | | SPECULATIVE OFFICE SPACE | |
|---|---|---|---|---|
| | Electricity (kWh) | Fossil Fuel Thermal (kWh) | Electricity (kWh) | Fossil Fuel Thermal (kWh) |
| Unit A - 145 | 19,950 | 102,600 | 30,875 | 39,000 |
| Unit B - 140 | 24,850 | 127,800 | 22,800 | 28,800 |
| Unit C - 138 | 19,950 | 102,600 | 23,750 | 30,000 |
| Unit D - 141 | 34,650 | 178,200 | 57,000 | 72,000 |
| Unit E - 142 | 19,250 | 99,000 | 30,400 | 38,400 |
| Unit F - 139 | 11,200 | 57,600 | 14,250 | 18,000 |
| Unit G - 149 | 3,150 | 16,200 | 0 | 0 |
| Unit H - 148 | 16,975 | 87,300 | 34,200 | 43,200 |

*Table 8 – Estimated annual energy consumption.*

## 3.2. Annual energy distribution by end use

The results presented below show the proportion of energy estimated for each of the proposed technical units at Bicester Heritage. It has to be noted that at this stage the assumptions were based on a SBEM analysis shell and core assessment carried for unit B 140. Figure 3 below shows the proportion of energy end use of all proposed technical units..

| UNITS | SPACE HEATING (KWH) | COOLING (KWH) | AUXILIARY (KHW) | LIGHTING (KWH) | DOMESTIC HOT WATER (KWH) | EQUIPMENT (KWH) |
|---|---|---|---|---|---|---|
| Unit A - 145 | 132,470 | 2,930 | 1,553 | 16,565 | 9,130 | 29,776 |
| Unit B - 140 | 146,503 | 2,747 | 1,456 | 15,530 | 10,097 | 27,916 |
| Unit C - 138 | 124,050 | 2,520 | 1,336 | 14,243 | 8,550 | 25,602 |
| Unit D - 141 | 234,068 | 5,284 | 2,801 | 29,871 | 16,132 | 53,693 |
| Unit E - 142 | 128,541 | 2,863 | 1,518 | 16,182 | 8,859 | 29,087 |
| Unit F - 139 | 70,726 | 1,467 | 778 | 8,295 | 4,874 | 14,910 |
| Unit G - 149 | 15,155 | 0 | 102 | 1,089 | 1,045 | 1,958 |
| Unit H - 148 | 122,086 | 2,951 | 1,564 | 16,679 | 8,414 | 29,981 |
| | | | Regulated Energy | | | Unregulated Energy |

*Table 9 – Estimated annual energy consumption.*

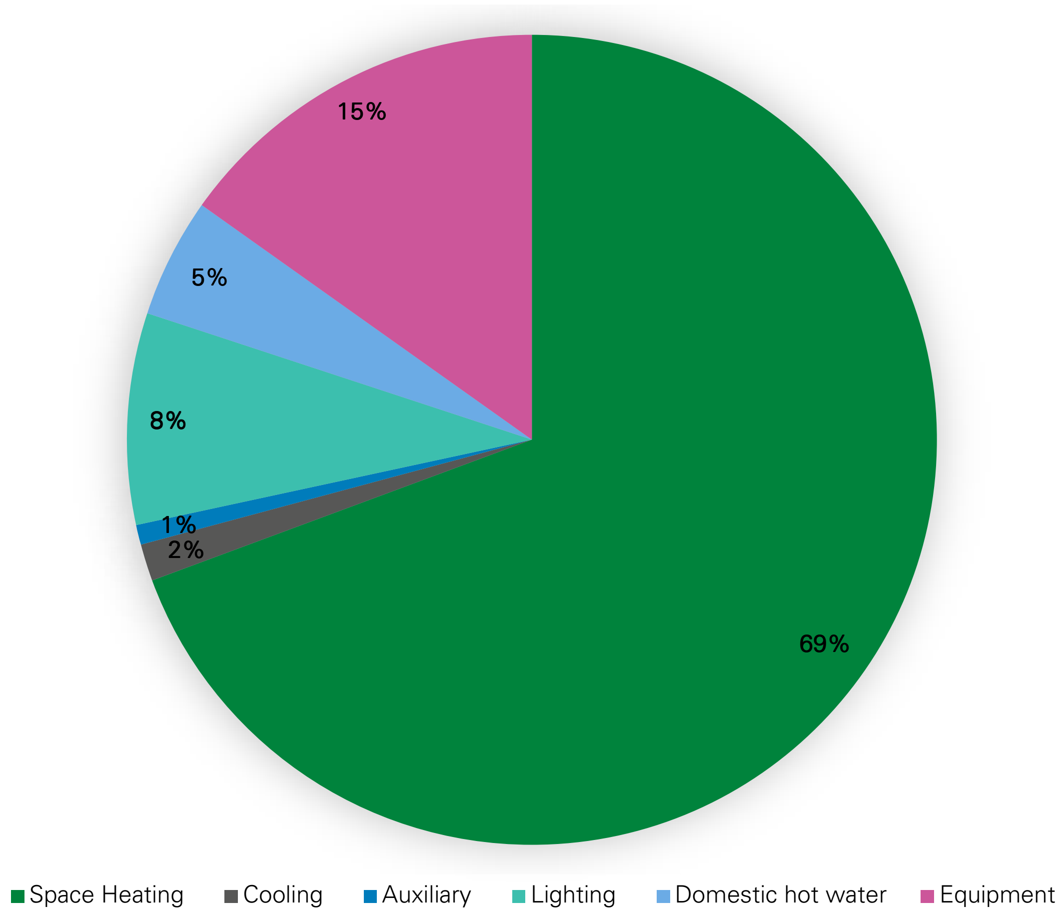



*Figure 3 – Estimated annual energy end use for the proposed technical units at Bicester Heritage.*

## 3.3. Energy Hierarchy

After estimated the baseline energy consumption for the proposed site. An assessment to predict the energy reduction potential the Be Lean and Be Clean measures had was carried out. The results presented below in Table 10 illustrate the estimate energy contribution (*by end use) each of the Energy Hierarchy steps achieved.

| STAGE | SPACE HEATING (KWH) | COOLING (KWH) | AUXILIARY (KHW) | LIGHTING (KWH) | DOMESTIC HOT WATER (KWH) | EQUIPMENT (KWH) |
|---|---|---|---|---|---|---|
| Base | 973,599 | 20,763 | 11,108 | 118,456 | 67,101 | 212,923 |
| Be Clean | 645,155 | 23,867 | 11,108 | 118,456 | 67,101 | 212,923 |
| Be Lean | 633,906 | 23,785 | 9,445 | 112,868 | 67,101 | 212,923 |

*Table 10 – Be Lean and Be Clean estimated annual energy consumption.*

## 3.4. Annual $CO_2$ emissions

### ASHP Scenario

The following results summarise the $CO_2$ emissions reduction estimated when implementation ASHP serving the space heating for the workshop areas (Gas fired ASHP assumed) and space heating and comfort cooling to the speculative office spaces (VRF / VRV System assumed).

| KEY | TONNES OF CO2 PER ANNUM | TONNES OF CO2 PER ANNUM |
|---|---|---|
| Baseline $CO_2$ emissions | 404 | 111 |
| $CO_2$ emissions after Be Lean measures | 300 | 111 |
| $CO_2$ emissions after Be Clean measures | 293 | 111 |
| $CO_2$ emissions after Be Green measures | 236 | 111 |
| | Regulated Emissions | Unregulated Emissions |

*Table 11 – Energy Hierarchy annual $CO_2$ emissions*

| REGULATED CARBON DIOXIDE EMISSIONS SAVINGS FROM EACH STAGE OF THE ENERGY HIERARCHY | | |
|---|---|---|
| | **Regulated Carbon dioxide emissions** | |
| | Tonnes $CO_2$ per annum | (%) |
| Be Lean: Savings | 103 | 26% |
| Be Clean: Savings | 7 | 2% |
| Be Green: Savings | 57 | 14% |
| Total Cumulative Savings | 167 | 41% |

*Table 12 – Regulated emissions savings at each stage of the energy hierarchy*

Table 11 above show the sites overall $CO_2$ emissions after each stage of the energy strategy these figures were broken down into regulated and unregulated energy. Table 12 show the potential savings each stage of the energy hierarchy offers.

# 4. RECOMMENDATIONS AND CONCLUSIONS

The following design measures are recommended for inclusion in the design development of the proposed New Technical Units at Bicester Heritage:

Be Lean measures:

- Reduced heating demand - achieved by improved U-values, low air permeability and glazing optimization. These measures will reduce the heat loss through the building fabric and uncontrolled ventilation.
- Ventilation – the use of natural ventilation where possible.

Be Clean measures:

- Provide high efficiency internal and external lighting throughout the proposed units.
- Develop an efficient lighting control strategy which includes photoelectric (daylight) sensing and occupancy presence detection were applicable. External lighting is to be linked to daylight sensors and a timer only to provide lighting when it is required.
- Use variable speed drives on pumps and fans where applicable.
- All duct-work and pipework to be suitably insulated.
- Develop a metering and sub-metering building services strategy to monitor energy used within all proposed units.
- Where applicable use highly efficient heat recovery ventilation system.
- Due to the low DHW demand anticipated within the proposed units, consider the use of instantaneous DHW systems to reduce system standby/storage losses.
- Ensure that energy efficient white goods are installed within the proposed Technical Units.

Be Green Measures:

The following LZC technologies are recommended for the proposed building:

Our recommended approach is to outline the following technologies for each technical unit Fit-out.

| LZC TECHNOLOGY | SUITABILITY |
|---|---|
| Air Source Heat Pumps | Suitable<br>Recommended. |
| Photovoltaic Panels | Feasible<br>Recommended (please note that further advice and consultation with the CAA is required to assess the panels implementation. |

# 5. APPENDIX ONE – LZC FEASIBILITY STUDY

| PHOTOVOLTAIC TECHNOLOGY | |
|---|---|
| System Description | Photovoltaic (Solar PV) systems use solar cells to convert sunlight into electricity. These cells consist in either one or two layers of a semi-conducting material, usually silicon. When light shines on the cells it creates an electric field across the layers, causing electricity to flow. The greater the light intensity the greater the flow of electricity. There are three basic kinds of solar cells:<br>▪ Mono-crystalline: Typical efficiency = 13%<br>▪ Polycrystalline: Typical efficiency = 11%<br>▪ Thin film: Typical efficiency = 9%<br>In the northern hemisphere, this technology is ideally located on inclined south-facing facades or roofs of a building. The units work at their highest efficiency when inclined between 20-40$^{o}$ from horizontal and facing within 20$^{o}$ of due south |
| Key Consideration: | Advantages:<br>▪ Electrical generating technology – good for a building with a large electrical load.<br>▪ A true renewable technology.<br>▪ Tried and tested technology with good payback periods.<br>▪ Large area of roof available to install PV – ideal.<br>Disadvantages:<br>Significantly reduced output during winter months particularly during snowy conditions. |
| Land Use / Roof Use | Suitable roof area for this technology must refer to the sensitivity of the system's performance to orientation, tilt angle and local shading obstructions. The building's roof would allow for solar panels to be orientated and tilted in a favourable location. |
| Local Planning Criteria | Local authorities can sometimes impose restrictions where glare from reflected sunlight off the panels could cause nuisance or problems with the local area. Advice should be sought from the relevant body. |
| Noise | The panels themselves are silent as they have no moving parts, however the only source of minor noise may be the inverter. This piece of equipment is not usually located anywhere near a frequently occupied space for safety reasons, therefore noise is not considered to be an issue for this technology. |
| Possibility of electricity export | Should the generation of electricity from the PV system exceed the requirement of the building at any point, it can be exported and sold to the grid. Utilities providers typically offer two different rates for the electricity based upon the predictability of electricity exported. Suitable measures and infrastructure to enable the system to export electricity are typically inexpensive and relatively simple for small systems, but co-ordination with the local district network operator is usually necessary. |
| Available Grants | Currently a Feed-in tariff for any Solar PV with total installed capacity of 250kWp but not exceeding 1MWp of 1.25p/kWh can be obtained for a system on a new build property (Assuming the system installed between 1st of Jan and March 2019). |

| PHOTOVOLTAIC TECHNOLOGY | |
|---|---|
| Summary | PV System is considered an option for The Bicester Heritage Technical Site.<br>It must be noted that the current proposals do offer adequate roof space for this technology, however due to the sites locations (Bicester Air Field) further health and safety considerations are to be reviewed with the civil aviation authority (CAA). |

| SOLAR THERMAL TECHNOLOGY | |
|---|---|
| System Description: | Solar thermal is a system for generating hot water from the sun. Typical systems consist of a circulation loop filled with glycol that runs from a solar collection box into a hot water storage tank. In the solar collection box, the sun heats the glycol coil with brings the heat into the hot water tank effectively acting as an electric emersion heater, heating the water in the tank. This type of system can act alone as a water heater or as a pre-heat, bringing the mains water up in temperature before it is heated to LTHW temperatures (for heating) or domestic hot water temperatures. |
| Key Consideration: | Advantages:<br>▪ Low running costs.<br>▪ Not carbon intensive.<br>▪ Minimal upkeep.<br>▪ Low operating costs.<br>▪ Can add efficiency to an existing system.<br>▪ Eligible for renewable heat incentive.<br>Disadvantages:<br>▪ Usually a long payback period.<br>▪ Requires a hot water storage tank, sometimes an additional one.<br>▪ Takes space away from more efficient PV panel on a roof array.<br>Only focuses on Domestic hot water, which is a small proportion of overall energy consumption. |
| Land Use / Roof Use: | Most commonly installed as a roof mounted system. |
| Local Planning Criteria: | Local authorities can sometimes impose restrictions where glare from reflected sunlight off the panels could cause nuisance or problems with the local area. Advice should be sought from the relevant body within the Salisbury/Wiltshire planning requirement. |
| Noise: | The panels themselves are mostly silent save for the occasional sound of running water. There is a pump in the plant room but depending on the system, this will shut off once the water begins moving. This piece of equipment is not usually located anywhere near a frequently occupied space for safety reasons, therefore noise is not considered to be an issue for this technology. |
| Possibility of electricity export: | The system should never be sized to meet more than the building's water heating base load. Therefore, there is no possibility of exporting heat from a solar thermal panel system. |
| Available Grants: | There are incentives through the Renewable Heat Incentive. |
| Summary: | Since there is not an high anticipated DHW constant demand on the proposed units to make the system work efficiently this system is not recommended for implementation. |

| WIND TURBINES | |
|---|---|
| System Description: | Wind turbines convert the wind's kinetic energy into electrical power. Wind turbines use large blades to catch the wind. When the wind blows, the blades are forced round, driving a turbine which generates electricity. The stronger the wind, the more electricity produced. They require an average annual wind speed of around 4-5m/s to generate power at a reasonable efficiency. In built-up areas, this speed is achieved moderately frequently at heights around 45m above ground level but is rarely witnessed below 25m above ground level.<br>There are two types of domestic-sized wind turbines:<br>Pole mounted: these are free standing and are erected in a suitably exposed position, often about 5kW to 6kW.<br>Building mounted: these are smaller than mast mounted systems and can be installed on the roof of a home where there is a suitable wind resource. Often these are around 1kW to 2kW in size. |
| Key Consideration: | Advantages:<br>▪ Electrical generating technology – good for a building with a large electrical load.<br>▪ Reduced electricity bills: Once the initial installation fee is paid, electricity costs will be reduced.<br>▪ Year-round generation.<br>▪ Reduced carbon footprint: Wind electricity is green renewable energy and doesn't release any harmful carbon dioxide or other pollutants.<br>▪ Good green credentials - an obvious visual statement of sustainability.<br>Disadvantages:<br>▪ Potentially quite expensive.<br>▪ Maintenance costs can be £100-£200 per year but can get as expensive at £2000 if the inverter need to be replaced.<br>▪ Likely to have planning issues.<br>▪ Availability of technologies locally, including availability of after-sales service.<br>▪ Lifespan can be longer than 20 years, but battery lifespan is only 6 to 10 years.<br>▪ Noisy. |
| Summary: | Due to the location of the site, there is limited space available on the site to accommodate this technology<br>It is anticipated that due to the sites location Wind Turbines may be restricted.<br>At this stage this technology is not recommended. |

| BIOMASS BOILERS | |
|---|---|
| System Description: | Biomass boilers generate heat through burning organic matter. The heat can either be used directly for heating, or to produce hot water or steam, the latter being more suitable for commercial applications. The most common fuel used in biomass boilers is wood, usually in pellet form which can be derived directly from forestry.<br>There are two predominant types of biomass boiler suitable for medium to large scale projects, determined by their type of fuel; wood pellet or wood chip. Pellet boilers tend to be physically smaller than chip fired equivalents as less robust feed and burning systems are needed. Additionally, the storage space required for fuel is less, making them preferable for a project with limited space. |
| Key Consideration: | Advantages:<br>▪ Often cheaper than other heating options.<br>▪ A low carbon heating option – lower if biomass is sourced locally.<br>▪ Funding available.<br>Disadvantages:<br>▪ Requires local supplier of wood pellets.<br>▪ Can be expensive.<br>▪ Requires additional space for pellet storage and delivery.<br>▪ Could have planning issues and large flue height to meet local regulations.<br>▪ Needs good maintenance regime to ensure good performance.<br>Will likely require gas boiler backup. |
| Land Use: | The space requirements are much more onerous than a conventional boiler, requiring a storage facility capable of holding a sufficient volume of wood fuel to limit the frequency of deliveries, especially during the winter period. The storage location for both the unit and chosen fuel must be designed to ensure adequate ventilation and automated fire suppression provision and the prevention of water dampening the fuel, lowering its efficiency. OAS project has enough space available and therefore the ability to locate a sufficiently sized and accessible storage facility is sufficient. |
| Local Planning Criteria: | It is only usually the storage facility of a biomass system that could require planning permission, should it be relatively large. However, the Nitrous Oxide ($NO_x$) emissions of a biomass system are typically greater than a gas-fired system and may require confirmation with local authorities as to its specification to ensure the emissions are limited to a specific level. Advice should be sought from the relevant body within the local council. |
| Noise: | A biomass boiler typically emits no more noise than a standard boiler system. A small amount of noise is emitted from the auger that feeds the combustion chamber, however this should not be sufficient to cause disruption. Noise is not considered an issue with regards to biomass heating systems. |
| Possibility of electricity export: | Biomass boilers are typically never oversized to enable heat export. Biomass boilers are seldom sized more than either the base load, or 80-90% of the peak load of a building. The rate of fuel consumption, and the required rate of fuel delivery directly affects the size of storage capacity, and a biomass system is typically sized to meet the sole needs of the building it serves. |
| Available Grants: | The Feed-in tariff for CHP generation applies only to units less than 2kW rated output (for domestic purposes), and therefore any unit capable of satisfying the centre's base load would not be eligible. Additionally, the Renewable Heat Incentive only applies to biomass-fuelled CHP units. |

| BIOMASS BOILERS | |
|---|---|
| Summary: | The use of this technology for individual unit is not feasible due to the shell and core nature of the development. The requirements for fuel storage and safe access to site for deliveries have been considered but at this stage this technology is not recommended.<br>A central biomass District heating system is viable, but it is not suitable due to the intended commercial leasing approach for each unit. This system would require an ongoing management from Bicester Heritage which is considered undesirable. |

| COMBINED HEAT AND POWER (CHP) | |
|---|---|
| System Description: | Combined Heat & Power (CHP) converts a single fuel into both electricity and heat in a single process at the point of use. CHP is highly energy efficient and as well as supplying heat and power, it can deliver many positive financial, operational and environmental benefits.<br>CHP is a well-proven technology, recognized worldwide as a viable alternative to traditional centralized generation. With CHP, an engine which is normally fuelled by natural gas, is linked to an alternator to produce electricity. CHP maximizes the fuel and converts it into electricity at around 35% efficiency and heat at around 50%. Heat is recovered from the engine by removal from the exhaust, water jacket and oil cooling circuits. Typically, a good CHP scheme can deliver an efficiency increase of anything up to 25% compared to the separate energy systems it replaces. |
| Key Consideration: | Advantages:<br>▪ Stabilized electricity costs over a fixed period.<br>▪ Reduce primary energy use.<br>▪ Reduced $CO_2$ emissions.<br>▪ Reduce transmission losses.<br>▪ Can use biomass, gas or oil.<br>Disadvantages:<br>▪ Cost.<br>▪ Creation of excess heat that will need to be dumped (unless it can be tied into a local system serving heat to local houses).<br>▪ Fuel delivery and storage for biomass.<br>▪ Maintenance costs can be high. |
| Land Use: | Needs a large area for the plant and storage of fuel. |
| Local Planning Criteria: | Same permissions needed as those for biomass boilers. |
| Noise: | Not significant. This piece of equipment is not usually located anywhere near a frequently occupied space for safety reasons, therefore noise is not considered to be an issue for this technology. |
| Possibility of electricity export: | Not likely. Commonly heat is overproduced, requiring more intensive delivery to external sources than electricity. |
| Available Grants: | The Feed-in tariff for CHP generation applies only to units less than 2kW rated output (for domestic purposes), and therefore any unit capable of satisfying the |

| COMBINED HEAT AND POWER (CHP) | |
|---|---|
| | centre's base load would not be eligible. Additionally, the Renewable Heat Incentive only applies to biomass-fuelled CHP units. |
| Summary: | The anticipated low constant demand of heat does not make the system work efficiently, CHP engine is not a suitable technology for the development. |

| GROUND TO AIR/WATER HEAT PUMPS | |
|---|---|
| System Description: | GSHPs are a tried and tested means of providing space and water heating to buildings, most often combined with under-floor heating. Such a heat distribution system is efficient due to low flow and returns temperatures and offers a low-carbon solution to achieve the required internal heating load.<br>As the ASHP the principle of operation revolves around the refrigerant (with a very low boiling point) being heated by the ground through an evaporator heat exchanger and pumped by a compressor to the indoor heat exchanger whereby it cools and condenses back to a liquid whilst expelling heat into the space. The system is therefore dependent on ground temperatures. |
| Key Consideration: | Advantages:<br>▪ Heat generating technology – Good for providing low carbon heat loads – very efficient with a borehole solution.<br>▪ Can also contributed to cooling loads in summer.<br>▪ No need for boiler, flues, cooling towers, chillers, water treatment or associated plant space.<br>▪ Significant reductions in CO2 emissions compared to conventional systems.<br>▪ Significantly lower running costs compared to conventional systems.<br>▪ High efficiencies in both heating and cooling modes.<br>▪ No noise implications to the site.<br>▪ Minimal maintenance.<br>▪ No fuel deliveries.<br>▪ Pairs well with PV panels as there is no transmission loss making the GSHP more efficient.<br>Disadvantages:<br>▪ Not a 'renewable' technology – just a low carbon technology. However, can have benefit if coupled with other electricity generating renewable (i.e. PV).<br>▪ Need a low temperature heating circuit – ideally suited to underfloor heating. This means that plant would be larger to accommodate lower temperatures.<br>▪ Will likely require boiler backup anyway.<br>▪ Can only operate in either 'heating' or 'cooling' modes at any one time.<br>▪ Large boreholes or below ground channels required for ground source.<br>▪ A license may be required to drill vertically.<br>▪ Generally, quite expensive with long payback periods.<br>▪ Some occupants find terminals unsightly. |

| GROUND TO AIR/WATER HEAT PUMPS | |
|---|---|
| | ▪ Costs more, primarily due to installation than an ASHP – can be less costly if pile loops are used. |
| Land Use: | The area of land used to install a GSHP system will be significantly different for a vertical loop (borehole) system in comparison to a trench arrangement (slinky or horizontal loop).<br>If pile loops are not used, extensive ground works need to be carried out to bury the thermal loops. |
| Local Planning Criteria: | Planning consent is not typically required for a GSHP system, unless a natural habitat is being disturbed by its installation. A site investigation and test borehole are however typically good practice to understand the ground build-up (and therefore the effect of system performance) and any existing obstructions or dangers to its installation such as drainage systems or contaminated land. |
| Noise: | The only noise emitted from a GSHP system is from the pumps. The noise is not typically extensive and can be easily attenuated within a suitably located enclosure or plant room. |
| Possibility of electricity export: | The system should be sized to meet the heating demands of the building it serves to achieve the greatest efficiency. |
| Available Grants: | Currently a payment by the renewable heat incentive of 8.95p/kWh can be obtained. |
| Summary: | Technically may be feasible but lack of space and budget constraints decrease the feasibility. It has to be noted that the technology is feasible at initial construction stage, but it is not viable for the proposed site due to the shell and core approach proposed. |

| AIR TO AIR/WATER HEAT PUMPS | |
|---|---|
| System Description: | ASHPs are an extremely efficient way of providing both heating and cooling to an internal building environment. Low-temperature heat, which occurs naturally in the air, is converted to high-grade heat by using an electrically driven or gas-powered pump. If the system utilizes a reverse-cycle heat pump, the system can be run in reverse to provide cooling. The principle of operation revolves around the refrigerant (with a very low boiling point) being heated by the outside air through an evaporator heat exchanger and pumped by a compressor to the indoor heat exchanger whereby it cools and condenses back to a liquid whilst expelling heat into the space. The system is therefore dependent on outside air temperature and does require a defrost cycle to be implemented in extreme winter conditions to prevent ice build-up on the evaporator. |

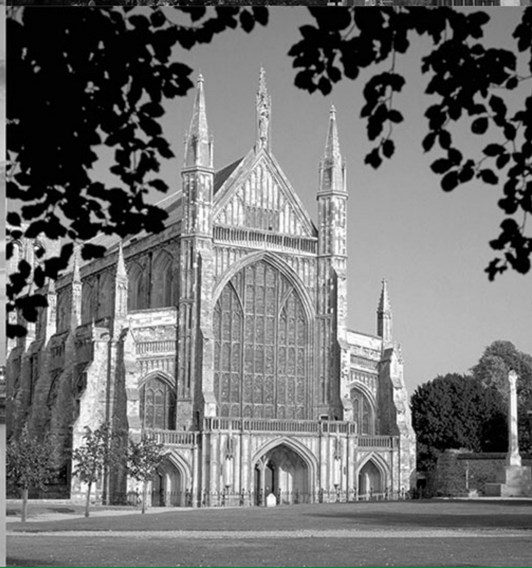
| AIR TO AIR/WATER HEAT PUMPS | |
|---|---|
| Key Consideration: | Advantages:<br>▪ Minimal maintenance.<br>▪ Provide heating and cooling.<br>▪ No fuel deliveries.<br>▪ Coefficient of Performance (COP) is between 2 and 3.<br>▪ Pairs well with PV panels as there is no transmission loss making the ASHP more efficient.<br>▪ Works well with underfloor heating.<br>Disadvantages:<br>▪ Due to colder local conditions, efficiencies could be very poor during winter.<br>▪ Not a 'renewable' technology – just a low carbon technology. However, can have benefit if coupled with other electricity generating renewable (i.e. PV).<br>▪ Need a low temperature heating circuit – ideally suited to underfloor heating. This means that plant would be larger to accommodate lower temperatures.<br>▪ Will likely require boiler backup anyway.<br>▪ Generally, quite expensive with long payback periods.<br>▪ Some occupants find terminals unsightly.<br>▪ Condensers can be noisy. |
| Land Use: | ASHPs require sufficient access to outside air and cannot therefore be completely enclosed. They are usually located on the roof or adjacent to the building. |
| Local Planning Criteria: | ASHPs do not typically affect planning criteria. They are however, a significant source of noise which is discussed in the next heading. |
| Noise: | ASHPs do make some noise when operating as both a fan and a compressor will be in motion. Whilst the airflow cannot be obstructed, attenuated enclosures or screens can reduce the noise significantly, but location is still important to reduce disruption and interference. Acoustic tests on site can be required by building control to assess noise pollution to any sensitive surrounding areas. |
| Possibility of electricity export: | The system should be sized to meet the heating demands of the building it serves to achieve the greatest efficiency. |
| Available Grants: | Currently a payment by the renewable heat incentive of 2.57p/kWh can be obtained. |
| Summary: | Air source heat pumps are a suitable technology for the proposed technical units. This technology offers low carbon heating and cooling and its applicability to offices space is beneficial in terms of energy and $CO_2$ emissions. Technologies to be considered further as design development during the Fit-out stage . |

| WATER TO AIR/WATER HEAT PUMPS | |
|---|---|
| System Description: | An Open Water Heat Pump system works by recovering the solar energy stored naturally in river water or open water. The water then passes through heat pumps to yield its low-grade heat before being returned to the river with a temperature change of 3°C. Water source heat pumps (WSHP) work the same way as ASHPs and GSHPs where the thermal loops collect heat or cold and deliver it to the unit to be converted. |
| Key Consideration: | Advantages:<br>▪ Minimal maintenance.<br>▪ Provide heating and cooling.<br>▪ No fuel deliveries.<br>▪ The high thermal capacity of water promotes an efficient transfer of energy.<br>▪ Has a much larger area of heat to draw from as it is a liquid-based heat store.<br>▪ Pairs well with PV panels as there is no transmission loss.<br>▪ Works well with underfloor heating.<br>Disadvantages:<br>▪ Some occupants find terminals unsightly.<br>▪ Stricter environmental regulations are faced if open loops are used.<br>▪ Cannot store summer heat in the water to extract in the winter.<br>▪ Loops are more easily damaged by recreational activities or the environment as they are installed in waterbodies.<br>Not as low carbon an option if using mains electricity. |
| Summary | There is no access to bodies of water at the site, so this option is unfeasible. |

| SMALL SCALE HYDRO ELECTRIC | |
|---|---|
| System Description: | Hydro power systems convert the potential energy of elevated water into kinetic energy in a turbine, which drives a generator to produce electricity. The greater the height and the more water there is flowing through the turbine, the more electricity can be generated. The amount of electricity a system generates depends on how efficiently it converts the power of the moving water into electrical power. |
| Key Consideration: | Advantages:<br>▪ Efficient energy store: it takes only two gallons per minute to generate electricity with micro-hydro.<br>▪ Reliable: follows electricity demand in the UK with higher rainfall in the winter.<br>Disadvantages:<br>▪ Requires flowing water nearby.<br>▪ Reduced production in the summer months. |
| Summary: | There is no flowing water near the site, so this option is not feasible. |





www.ridge.co.uk