LONDON ROAD COUNCIL OFFICES

DECARBONISATION PLAN

UTTLESFORD DISTRICT COUNCIL

d3associates
ENERGY & ARCHITECTURE

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PREPARED FOR

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CB11 4ER

UTTLESFORD DISTRICT COUNCIL

LONDON ROAD COUNCIL OFFICES

DECARBONISATION PLAN

D3A-1912-015-T13-R2

Report
May 2024
D3 Associates Ltd

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EXECUTIVE SUMMARY

D3 Associates Ltd have been appointed to prepare a Decarbonisation Plan for London Road Council Offices, Saffron Walden, CB11 4ER as part of a study on how to decarbonise some of Uttlesford District Council buildings.

BUILDING FABRIC

Based on information provided and observed during the site survey, the existing building fabric is summarised in the table below:

Element	Detail	Estimated U-values	Insulation Potential	Notes
Floors	Mainly concrete with a variety of coverings	1.2	No	Appears to be in fair condition, unlikely to have any insulation, not practical to improve.
Walls	Solid brick	1.6	No	Walls appear to be in fair condition, not practical to improve.
Roof	Pitched slate roof.	2.5	Yes	Condition of roof appears fair, though localised repairs required, no insulation present, therefore, new roof void insulation recommended.
Windows	Single glazed timber, some with secondary glazing	4.8	Yes	Windows appear to be in fair condition, some recently replaced. Secondary glazing generally in poor condition, requires replacing.
Doors	Timber	3.0	No	Doors are in good condition.

Table ES1: Summary of the building fabric – Main building

Element	Detail	Estimated U-values	Insulation Potential	Notes
Floors	Mainly concrete with a variety of coverings	0.6	No	Appears to be in fair condition, likely to have some insulation, not practical to improve.
Walls	Brick cavity walls	0.6	No	Walls appear to be in fair condition, likely to have some insulation, not practical to improve.
Roof	Pitched slate roof. Also, flat & domed sections with single ply or liquid resin covering.	0.35	Yes	Condition of roof appears fair, though repairs to the pitched roofs and some resin roofs require replacement. Insulation between rafters or as part of single ply membrane, not practical to improve.
Windows	Double glazed aluminium, some with secondary glazing.	2.8 & 3.4	Yes	Most windows appear to be in fair/poor condition and coming to the end of their design lives. Options to either replace windows or install all with secondary glazing.
Rooflights & glazed atrium	Double glazed aluminium.	3.4	Yes	Rooflight glazed units have failed, require replacing with improved specification. Glazed atrium has blown double glazed seals and reports of severe water ingress. Options to either replace affected units or dismantle and construct alternative.
Doors	Double glazed aluminium	3.0	No	Doors are in good condition.

Table ES2: Summary of the building fabric – Extension

HEATING SYSTEM

The existing Heating System Compromises of:

- Two Gas Fired Hamworthy Fleet F250V Boilers (Nominal Output 250kW each). The heating is distributed via a shunt pump to a Plate Heat Exchanger (PHE) which provides hydraulic separation from the existing heating systems. From the PHE there are three LPHW distribution systems; variable temperature heating to the main building, variable temperature to the extension and a constant temperature circuit each are fitted with duty and standby belt driven pumps.
- Domestic hot water is generally provided by point of use electric water heaters located in WC's and tea making sinks. All appeared to be in good working order. A control panel is located in the boiler room which provides power and control to the heating plant.
- The heating system within the main building has a number of original cast iron radiators all retrofitted with Thermostatic Control Valves (TRV's) and newer steel panel convector radiators. The extension has mainly newer steel panel convector radiators al fitted with TRV's. There are a limited number of fan convector type heaters controlled from local thermostats. The heating system is pressurised via a pressurisation unit. A dosing pot is provided for the chemical dosing of the heating system.

The boilers were installed circa 2013 and therefore only approximately 11 years old, however the bottom boiler has a condemned notice on the facia and was not operating. The belt driven circulation pumps were of various ages, and appeared to be operating satisfactorily however in general terms the older pumps are reaching the end of operational life. The control panel itself appears to have been pre 2013 upgrade, with labelling out of date, although a new Trend IQ4 controller was installed circa 2013. The heating systems are a mixture of ages, all systems appeared to be in satisfactory condition.

ENERGY AUDIT

The existing annual energy consumption, costs and associated carbon emissions are summarised as follows:

Item	Electricity	Gas	Total
Annual Consumption, kWh	277,655	534,606	812,261
Tariff, £/kWh	0.3354 (Average)	0.1081 (Average)	
Annual Cost, £	93,113	50,282	143,396
Annual Carbon Emissions, kgCO2e	57,502	98,154	155,656

Table ES3: Summary of Annual Energy Consumption for March 2023 to February 2024

ENERGY SAVING MEASURES

The following proposed energy saving measures have been identified:

Component	Proposal	Reason	Overall Impact to Carbon Reduction
Draughtproofing	Repair/replace door & window seals. Adjust main entrance door operation.	Reduce uncontrolled air infiltration	Medium
Roof insulation	Insulate roof voids to Main building with 300mm rockwool.	Improve U-value to 0.18 W/m^{2}K	Medium
Windows	Main building - Install high performance secondary glazing units.	Improve U-values to, 1.6W/m^{2}K &	Medium
Lighting	Replace all older type fluorescent tubes with LED	Reduce electricity consumption	High

Table ES4: Recommended Energy Saving Measures

Adopting all the proposed measures shows a reduction in the peak heat loss from 400kW to 355kW.

In addition, the installation of solar PV has the following benefits:

Solar PV array size, kWp	Estimated Annual Generation, kWh	Electricity used within the building, kWh	Electricity exported to the Grid, kWh	Estimated Annual CO_2 Reduction, $kgCO_2$
40	39,920	39,816	104	3,982

Table ES5: Solar PV Generation, Battery Storage and Carbon Savings

LOW CARBON HEATING

Based on a qualitative analysis, the following system is recommended:

- As the existing gas fired boilers are over 10 years old, the recommendation is to replace the boiler with an Air-to-Water heat pump system; 8no. Mitsubishi CAHV 40kW. The obvious location for the heat pumps is preferably close to the Boiler Room.

ECONOMIC MODELLING

An analysis of the proposed energy saving measures is included in the table below. Cost estimates are based on quotations or recent project experience and can be used as budget figures. They include for contractor's prelims and overheads and profit at 15% and project management at 10%, however, exclude VAT.

- Draughtproofing – based on a Provisional Sum of £4,000.
- Pitched roof insulation – based on a cost of £25/m2.
- Secondary glazing to Main building – based on £250/m2.
- LED lighting – budget cost of £275,000.
- Solar PV - based on a cost of £1,000/kWp
- Energy Savings are based on electricity and gas tariffs of 33.5p/kWh and 10.8p/kWh respectively.
-

Measure	Estimated Capital Cost, £	P.F.[1]	Annual			Lifetime			Cost Per tonne of Lifetime CO_2 £/LTt	Simple Payback period, Years	Include in Decarb Plan?
			Energy Savings, kWh/Year	Carbon Savings tonnes CO_2/Year	Cost Savings, £/Year	Energy Savings, kWh	Carbon Savings tonnes CO_2	Cost Savings, £			
1. Draughtproofing	4,000	29.25	26,730	4.9	2,890	781,861	143.5	84,519	28	1	Yes
2. Roof insulation	12,500	27	37,780	6.9	4,084	1,020,052	187.2	110,268	67	3	Yes
3. Secondary glazing	38,143	7.92	24,376	4.5	2,635	193,062	35.4	20,870	1,077	14	Yes
5. LED Lighting	275,000	25	65,846	6.6	22,085	1,646,150	164.6	552,119	1,671	12	Yes
6. Solar PV	40,000	22.5	39,816	4.0	13,354	895,860	89.6	300,471	446	3	Yes
Total	**369,643**		**194,548**	**27**	**45,048**	**4,536,985**	**620**	**1,068,247**			

Table ES6: Economic and Carbon Analysis of the Proposed Energy Saving Measures.

A financial and carbon analysis of the full project including the recommended energy saving measures, ASHP to replace the gas boiler and on-site electricity generation is included in the table below.

Estimated capital cost of the full Air-to-Water Heat Pump system is £300,000 (cost includes deduction for replacement of gas boilers as required for PSDS).

Future carbon emissions for grid electricity are based on the long-term marginal 2030 figure of 0.1kgCO_2e/kWh.

Measure	Estimated Capital Cost, £	P.F.[1]	Annual			Lifetime			Cost per tonne of Lifetime CO_2, £/LTt	Simple Payback Period, Years
			Energy Savings, kWh/Year	Carbon Savings, tonnes CO_2e/Year	Cost Savings, £/Year	Energy Savings, kWh	Carbon Savings, tonnes CO_2e	Cost Savings, £		
Full ASHP System + Recommended Energy Saving Measures	£669,643	20	417,408	86.4	18,483	12,885,150	1,810	536,949	£370	N/A

Table ES7: Economic and Carbon Analysis of the Proposed Energy Saving Measures and Low Carbon Heating System

[1] P.F. is the Persistence Factor for the ASHP taken from the Phase 3C PSDS Application Form V1.1

CONCLUSION

As stated throughout the process and illustrated within this report, a building fabric first approach has been taken.

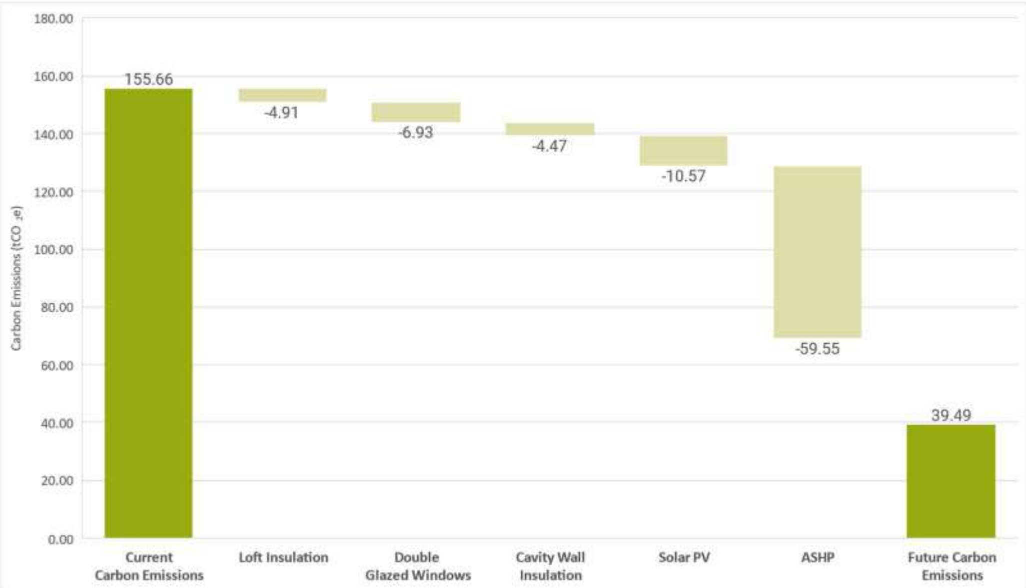
Appropriate energy saving measures have been considered for the building and usage. Adopting all the proposed measures shows a reduction in the peak heat loss from 400kW to 355kW.

The recommended building fabric improvements plus the ASHP heating system have an estimated capital cost of £669,643 which results in a lifetime carbon saving cost of £370/LTtCO_2, above last year's Salix threshold figure of £325/LTtCO_2.

Following detailed design and firm pricing and review of the guidance to Phase 4 of the Public Sector Decarbonisation Scheme (PSDS), the economic and carbon analysis to be updated. Further discussion to be undertaken to finalise which energy saving measures are to be included in the application.

The installation of additional solar PV panels with an anticipated size of 40kWp would generate around 39,900kWh per year with virtually all used directly within the building helping to lower annual operating costs.

The waterfall chart below shows the stepped reduction in overall carbon emissions considering both fossil fuel usage and electrical usage. Current carbon emissions are based on a grid electricity emission factor of 0.207kgCO_2e/kWh, whereas future carbon emissions are based on the long-term marginal 2030 figure of 0.1kgCO_2e/kWh.



CONTENTS

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ENERGY & ARCHITECTURE

1.0 INTRODUCTION

1.1 PURPOSE

Uttlesford District Council ("the Council") comprises all local government activity and council services in Uttlesford District. The Council owns sites across the area and provide services at primary and secondary schools, care homes, libraries, leisure centres and offices.

Uttlesford District Council has committed to reducing carbon emissions. To this end, the purpose of these Decarbonisation Plans is to help inform the journey to becoming carbon neutral.

1.2 SCOPE

The decarbonisation plans will review the current energy efficiency and consumption of the building and to provide a recommendation report including suitable technologies to be installed in the building to improve its efficiency both in terms of cost and carbon. The technology recommendations will include initial cost and payback in order to inform a business case for each proposal.

The plans adopt a holistic approach and the appraise different technology options. The assessments include consideration of the following:

- Building Fabric Improvements – for example, insulation, glazing and addressing draughts and thermal bridging
- Energy Control Systems;
- LED Lighting including advanced controls;
- Renewable Energy Technologies to be specified for all buildings especially to meet heating demands. Specifically, this should include appraisal of:
    - Air to Water Heat Pump Technology (Low and High Flow Temperature);
    - Air to Air Heat Pump Technology.
    - Hybrid Systems;
    - Electric Boiler Technology;
    - Ground Source Heat Pump;
- Energy Storage.
- Introducing Variable Speed Drives (VSD) for fans, pumps and compressors
- Systems offering better use of Heat, including Boilers, Radiators, Heat Pumps.

In addition, consideration of the impact of changing gas fired boiler heating loads to electric sources and whether the building has sufficient incoming capacity.

1.3 OBJECTIVES

The Objectives are to:

- Produce a Decarbonisation Plan for London Road Offices providing options for low carbon heat systems.

- Minimise primary energy demand by taking a fabric first approach, but also achieve reasonable funding metrics such as £/tCO_2e.
- Undertaking a holistic approach for the building suggesting a priority programme.

1.4 SITE SURVEYS

The site survey at London Road Offices took place on 16th April 2024 by representatives of D3 Associates Ltd.

2.0 SITE INFORMATION

2.1 OVERVIEW

The London Road Council Office is situated off London Road in Saffron Walden.

Address: London Road, Saffron Walden, Essex CB11 4ER.

The building is Grade II Listed and in the Saffron Walden Conservation Area.

The main building (original Old Saffron Walden Hospital) was built between 1863 and 1866, is two storey with attics, solid brick walls and steel framed, pitched slate roofs with clay ornate ridge tiles. Windows are predominantly single glazed, timber frame units, some with secondary glazing. Doors are mainly timber with single glazing. The building has undergone considerable internal refurbishment.

The three storey extension, constructed in 1990, has brick cavity walls and pitched slate roofs. Windows and doors are single glazed aluminium some with secondary glazing.

There is a glazed link building added in 1988/90.

There is current access 24/7 365 days per year though principal usage is during normal working hours.

Photo 1: Bing Maps Image

2.2 BUILDING DETAILS

2.2.1 BUILDING FABRIC

Building Details are shown below in Table .

Building Details	Parameters
Building Name	London Road Offices
Building Type	Offices
UPRN (Unique Property Reference number)	200004267308
Display Energy Certificate Rating (DEC)	(2020) 74 C
Building Age (Years)	160 & 34 years
Postcode (buildings must be on the same site)	CB11 4ER
Gross Internal Area of Heated Areas (m2)	4,616
Existing Annual Fossil Fuel Use (kWh p.a.)	534,606
Existing Annual Electricity Use (kWh p.a.)	277,655
Peak Heat Loss – Pre-Improvements (kW)	400
Peak Heat Loss – Post-Improvements (kW)	355
Existing Total Cooling Load – If Applicable (kW)	≈40

Table 1: Building Details

The table below summarises the individual building elements, estimated U-values with potential energy saving measures.

The U-values are based on assumptions and historical values for the time period the Offices were built and measurements from the drawings provided.

Element	Detail	Estimated U-values	Insulation Potential	Notes
Floors	Mainly concrete with a variety of coverings	1.2	No	Appears to be in fair condition, unlikely to have any insulation, not practical to improve.
Walls	Solid brick	1.6	No	Walls appear to be in fair condition, not practical to improve.
Roof	Pitched slate roof.	2.5	Yes	Condition of roof appears fair, though localised repairs required, no insulation present, therefore, new roof void insulation recommended.
Windows	Single glazed timber, some with secondary glazing	4.8	Yes	Windows appear to be in fair condition, some recently replaced. Secondary glazing generally in poor condition, requires replacing.
Doors	Timber	3.0	No	Doors are in good condition.

Table 2: Summary of the building fabric – Main building

Element	Detail	Estimated U-values	Insulation Potential	Notes
Floors	Mainly concrete with a variety of coverings	0.6	No	Appears to be in fair condition, likely to have some insulation, not practical to improve.
Walls	Brick cavity walls	0.6	No	Walls appear to be in fair condition, likely to have some insulation, not practical to improve.
Roof	Pitched slate roof. Also, flat & domed sections with single ply or liquid resin covering.	0.35	Yes	Condition of roof appears fair, though repairs to the pitched roofs and some resin roofs require replacement. Insulation between rafters or as part of single ply membrane, not practical to improve.

Windows	Double glazed aluminium, some with secondary glazing.	2.8 & 3.4	Yes	Most windows appear to be in fair/poor condition and coming to the end of their design lives. Options to either replace windows or install all with secondary glazing.
Rooflights & glazed atrium	Double glazed aluminium.	3.4	Yes	Rooflight glazed units have failed, require replacing with improved specification. Glazed atrium has blown double glazed seals and reports of severe water ingress. Options to either replace affected units or dismantle and construct alternative.
Doors	Double glazed aluminium	3.0	No	Doors are in good condition.

Table 3: Summary of the building fabric - Extension

2.3 SITE SERVICES SUMMARY

The heating is provided by two gas boilers separated from the original heating existing system by a plate heat exchanger. From the plate heat exchanger there are three LPHW distribution systems. Space heating for the main building being mainly provided by a mix of cast iron and steel panel convector radiators, the extension is mainly provided by steel panel radiators.

The domestic hot water is provided by an electric point of use water heaters.

There is mechanical cooling present in sections of the site, select rooms have indoor DX units with respective outdoor units; these units are also capable of heating. Mechanical ventilation is provided by two Air Handling Units and serve the Council Chamber and Committee Room The majority of the building's cooling and ventilation is primarily done by natural ventilation. Extract ventilation fans are used for WCs.

Building is supplied with mains cold water which feeds directly into system.

2.4 ELECTRICAL SERVICES

The main incoming supply enters the building into the basement area. From the switchboard supplies are taken to distribution boards and large fixed supplies throughout the building. The main switchboard and distribution boards are in reasonable condition for their age and serviceable. Testing should be carried out as prescribed in BS7671. Additional metering should be considered. Whilst there was no indication of the actual incoming supply capacity, it is estimated to be a maximum of 300kVA, three phase.

2.5 HEATING SYSTEM

2.5.1 SYSTEM DESCRIPTION

Two Gas Fired Hamworthy Fleet F250V Boilers with a Nominal Output of 250kW each. The heating is distributed via a single shunt pump to a Plate Heat Exchanger (PHE), which provides hydraulic separation from the existing heating systems. The boiler primary circuit to the PHE is pressurised via an automatic top-up system and expansion vessel. From the PHE there are three LPHW distribution systems; variable temperature heating to the main building, variable temperature to the extension and a constant temperature circuit each are fitted with duty and standby belt driven pumps. All heating equipment has power and control provided from a panel fitted with a Trend IQ4 controller.

The heating system within the main building has a number of original cast iron radiators all retrofitted with Thermostatic Control Valves (TRV's) and newer steel panel convector radiators. The extension has mainly newer steel panel convector radiators all fitted with TRV's. There are a limited number of fan convector type heaters controlled from local thermostats.

The boilers were installed circa 2013, therefore only approximately 11 years old, however, the bottom boiler has a condemned notice on the facia and was not operating. The belt driven circulation pumps were of various ages, and appeared to be operating satisfactorily however in general terms the older pumps are reaching the end of operational life. The control panel itself appears to have been pre 2013 upgrade, with labelling out of date, although a new Trend IQ4 controller was installed circa 2013. The heating systems are a mixture of ages with some original cast iron hospital type radiators, all systems appeared to be in satisfactory condition.

Mechanical ventilation plant consisting of 2no. Air Handling Units (AHUs) that have been installed to serve the Council Chamber and the Committee Room. Both units are located in a second-floor plant room. AHU-1 serves the Council Chamber and consists of a supply air module with LPHW heating coil, humidification, DX cooling coil and a supply fan with variable speed drive, and an intake air duct with a motorised damper. The extract module consists of an extract fan with variable speed drive, and an exhaust air duct with motorised damper. The supply and extract modules are mounted one above the other with a plate heat exchanger and motorised damper. AHU-2 serves the Committee Room, this unit is identical to AHU-1 except for it being smaller and there are no variable speed drives for the supply and extract fans. Both units have power and control from a panel with a Trend IQ4 controller. Notes on this panel indicated that the Humidifiers and the DX Cooling had been disabled on both AHU 1 and 2.

For the toilet area adjacent to the Council Chambers, supply and extract ventilation fans and heating are controlled from this same panel.

The second-floor office 45 has been provided with two Heat Recovery Ventilation units which supply fresh air and exhaust extract air from the space. Cooling is provided is provided by 4no. ceiling cassette DX units with the outdoor units located on the balcony adjacent. Two of these units are labelled as manufactured in 2005 and the other two 2020. There is also an outdoor unit located next to the plant room, installed in 2016, that serves the adjacent office.

A cooling ceiling cassette is provided for the ground floor Office 13 with the outdoor units located in the adjacent courtyard.

An automatic smoke ventilation system is provided with two motorised louvres located in the turret above the atrium and the controllers located in the adjacent store.

All ventilation equipment and plant appeared to be operating satisfactorily, although the older outdoor units serving the second-floor office may be reaching the end of serviceable life.

It was noted than an emergency generator, control panel and associated ventilation system located in the basement was now redundant.

Domestic hot water is generally provided by point of use electric water heaters located in WC's and tea making sinks. All appeared to be in good working order.

Photo 2: Main Plant Room

Photo 3: Boilers

Photo 4: Typical radiator

Existing Heating System	Parameters
Make	Hamworthy
Model	Fleet F250V
Age of System (Years)	11 Years Old
Output Load per Unit (kW)	250kW
Number of Duty Units	One
Total Output Load (kW)	500kW
Gross Seasonal Efficiency	97%
Gas Consumption L/h	24.4
System to Supply Space Heating, DHW or Both	Space Heating
Does Fossil Fuel Heating System form part of a Multi-Building System?	No
Maximum Water Pressure (bar)	6
Minimum Water Pressure (bar)	0.5

Table 4: Existing Heating System

Decarbonisation potential: Yes

Potential solution: Refer to options appraisal in Section 5.

2.5.2 DOMESTIC HOT WATER

Domestic Hot Water (DHW) is provided by various point of use electric water heaters located by WCs and kitchenettes.

Decarbonisation potential: No

2.5.3 COOLING SYSTEM

There are various air conditioning units at this site, totalling an approximate cooling capacity of 40kW.

2.5.4 CONTROLS

A BMS is installed.

2.6 LIGHTING

Lighting Installation - Within the building there is a combination of different luminaire types, some LED, ranging from modular luminaires, downlights, suspended/surface mounted linear luminaires, surface mounted circular luminaires.

Generally, the lighting installation is in a working condition. It is unknown if the lighting levels are compliant with CIBSE or good practice recommendations.

The luminaires are in reasonable condition but some areas use older technology and these should be replaced using equivalent LED luminaires.

Lighting Control - The lighting throughout is generally controlled through manual switches and PIRs. There is good daylighting to the main entrance area and the use of photocells to turn lighting off when ambient lighting is sufficient should be considered. A control system for the lighting is provided to the Council Chamber.

Emergency Lighting - The emergency lighting throughout is generally provided through standalone LED luminaires, conversion kits to general LED luminaires and illuminated exit signage and is in good condition. The system appears to comply with BS5266.

External Lighting – There is minimal external lighting as the building is situated off main roads and side streets, all of which are well illuminated by street lighting.

Energy Saving Potential: Yes, refer to Section 4.

3.0 ENERGY AUDIT

3.1 SUMMARY OF ENERGY CONSUMPTION DATA

The total gas and electricity monthly energy consumption with costs has been provided by Uttlesford District Council; from March 2022 to February 2024.

Total costs include standing charges and other levies; therefore, the average tariff will include a proportion of these charges.

Item	Electricity	Gas	Total
Annual Consumption, kWh	277,655	534,606	812,261
Tariff, £/kWh	0.3354 (Average)	0.1081 (Average)	
Annual Cost, £	93,113	50,282	143,396
Annual Carbon Emissions, kgCO_2e	57,502	98,154	155,656

Table 5: Summary of Annual Energy Consumption for March 2023 to February 2024

Electricity and gas annual carbon emissions are based on the 2023 figures for the following emission factors[2] listed below in Table 6.

Energy type	Emission factor	Units
Electricity	0.2071	kgCO_2e/kWh
Gas	0.1836	kgCO_2e/kWh

Table 6: Carbon Emission Factors

[2] BEIS, 2024; *UK Government GHG Conversion Factors 2023 for Company Reporting, Condensed Set v1.1 2024.* Available at https://www.gov.uk/government/collections/government-conversion-factors-for-company-reporting

The monthly electricity consumption from March 2022 to February 2024 shows a fairly constant demand which is to be expected from offices without significant electric heating or cooling.

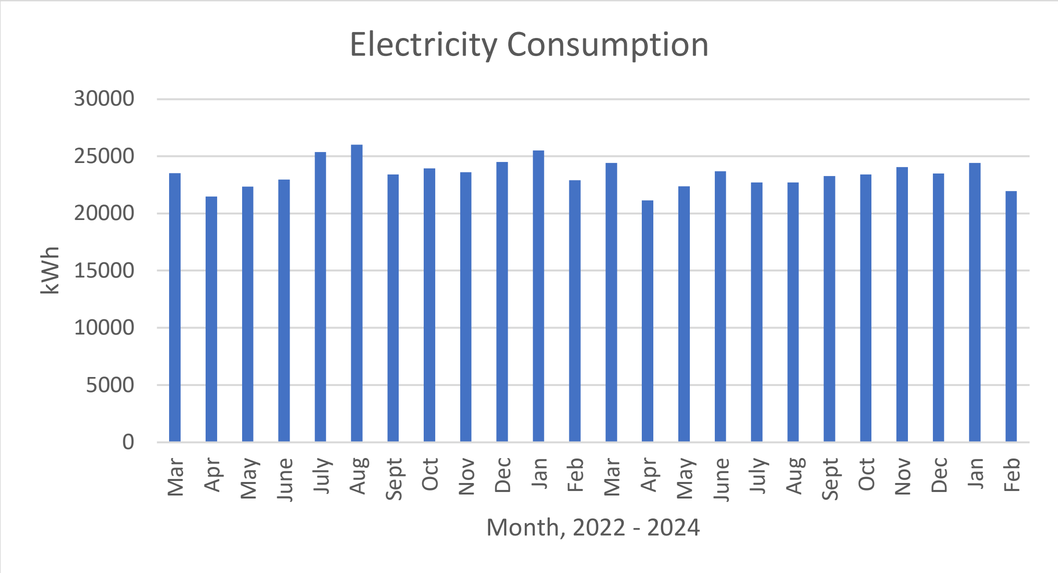

Figure 1: Monthly electricity consumption for March 2022 to February 2024

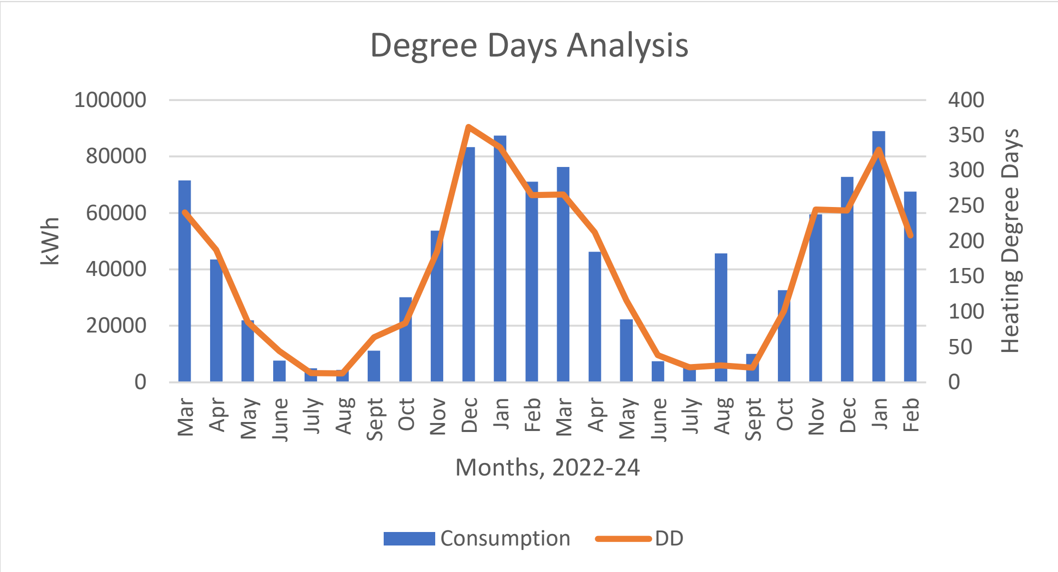

Figure 2: Monthly gas consumption with Degree Days for March 2022 to February 2024

Figure 2 shows the natural gas consumption alongside the Heating Degree Days (HDD) data for the same time period. HDD is a measure of the energy needed to heat a building calculated by recording outdoor temperature readings and tracking how long / how much the outside temperature was below a specific base temperature (15.5°C).

The gas consumption shows a fairly strong relationship with the degree days data indicating that the heating system is well-managed. This is despite some of the readings being estimated, the unusually high August reading is reportedly due to an actual reading making up for under estimated readings in previous months. To further assess the control of heating and associated gas consumption the following graph shows regression analysis.

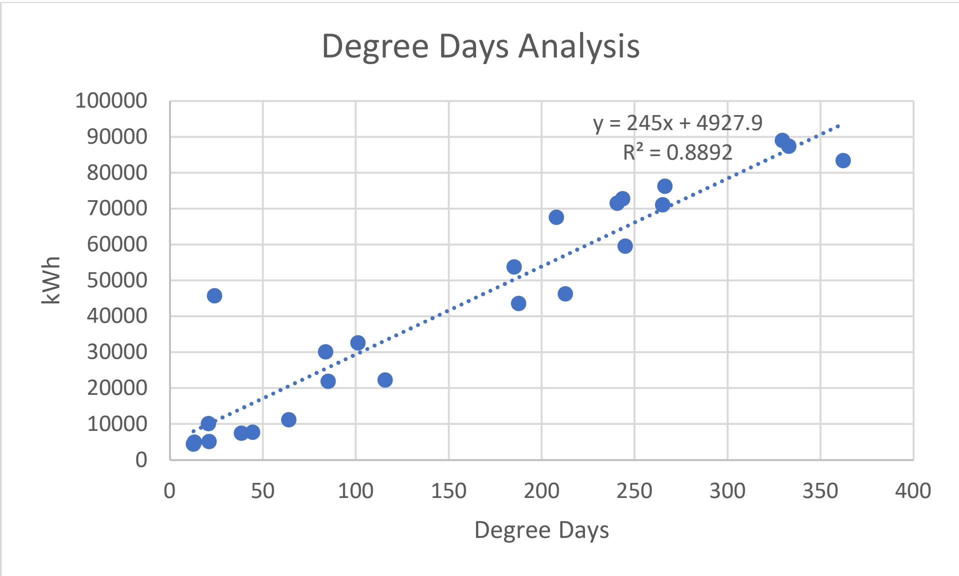

Figure 3: Degree Days with gas consumed

Figure 3 shows a strong relationship between gas consumption and degree days indicating there are few control issues or data issues (e.g. estimations, with the exception of August 2023). This is slightly surprising given the lack of zonal controls on the system, however, indicates the operation is well managed.

The equation on the graph shows two key points; firstly, is the R^2 value. As the R^2 tends to 1 the control of gas consumption in relation to the outside temperature (degree days value) improves. A value above 0.95 typically shows a very well-managed system. The R^2 value of 0.9 indicates that the heating controls are well-managed.

The second point is the y-intercept, in this case around 4,900kWh. As this site also uses gas for DHW this value indicates the minimum gas consumption required to maintain the DHW temperature.

3.2 DISPLAY ENERGY CERTIFICATE

The Display Energy Certificate (DEC) was issued in November 2020 and has now expired.

Uttlesford District Council
Uttlesford District Council
Council Offices, London Road
SAFFRON WALDEN
CB11 4ER

Operational rating

C

Certificate number:	7713-0810-3782-7309-6592
Valid until:	30 October 2021
Total useful floor area:	4,616 square metres

Energy performance operational rating

The building's energy performance operational rating is based on its carbon dioxide (CO_2) emissions for the last year.

It is given a score and an operational rating on a scale from A (lowest emissions) to G (highest emissions).

The typical score for a public building is 100. This typical score gives an operational rating of D.

Score	Operational rating	This building	Typical
0-25	A		
26-50	B		
51-75	C	74 C	
76-100	D		100
101-125	E		
126-150	F		
150+	G		

Previous operational ratings

Date	Operational rating
October 2020	74 C
October 2019	84 D
October 2018	86 D

Total carbon dioxide (CO_2) emissions

This tells you how much carbon dioxide the building emits. It shows tonnes per year of CO_2.

Date	Electricity	Heating	Renewables
October 2020	172	89	0
October 2019	205	87	0
October 2018	207	96	0

This building's energy use

Energy use	Electricity	Other fuels
Annual energy use (kWh/m2/year)	67.65	98.89
Typical energy use (kWh/m2/year)	95	120.88
Energy from renewables	0%	0%

Assessment details

Assessor's name	George Smith
Employer/Trading name	ACS Energy Services Ltd
Employer/Trading address	8 Frances Green, Chelmsford, CM1 6EG
Assessor's declaration	Not related to the occupier.
Accreditation scheme	Elmhurst Energy Systems Ltd
Issue date	25 November 2020
Nominated date	31 October 2020

Figure 4: Display Energy Certificate

3.3 ENERGY BENCHMARKING

The DEC rating for this building in 2020 was C, better than the typical rating for a public building. Note, in the preceding years, the rating was D. It is recommended a new Certificate is commissioned.

The 2020 DEC was compared against data for a public building, CIBSE have published new benchmarks based on more recent data. Our analysis compares actual consumption with those of a new category, Local Government Offices[3].

Based on the energy consumption data provided for 2023/4, the annual electricity consumption of 277,655kWh equates to 60kWh/m^2/year, which is around the CIBSE benchmarking guide for good practice for a Local Government Office of 62kWh/m^2/year.

The annual gas consumption of 534,606kWh equates to 116kWh/m^2/year, which is the significantly higher than the CIBSE benchmarking guide for typical practice, a value of 96kWh/m^2/year.

Overall consumption is very similar to typical practice for a Local Government Office.

	London Road Office Energy Usage (kWh/m^2)	London Road Office DEC Energy Usage (kWh/m^2)	Good standard Local government office Usage (kWh/m^2)	Typical standard Local government office Usage (kWh/m^2)	Variance from Good	Variance from Typical
Electricity	60	68	62	83	-3%	-28%
Gas	116	99	65	96	+78%	+21%
Total	176	167	127	179	+39%	-2%

Table 7: Energy Benchmark analysis

[3] CIBSE, 2021; CIBSE Guide F: Energy Efficiency in buildings

4.0 ENERGY SAVING MEASURES

4.1 WHOLE BUILDING APPROACH

Based on the information available from the DEC certificate, provided information and d3a walkaround, a number of opportunities to reduce the energy and heat demand on site have been examined.

It is recommended a fabric first approach is implemented prior to the installation of a low carbon heating system. A better insulated building will result in lower heat loss which in turn will reduce the size of the heat pumps and the electricity consumption.

4.2 DRAUGHT PROOFING

The first priority is to reduce draughts, also referred to as uncontrolled air infiltration. The ideal time to check for existing draughts is on a cold windy day. The areas to focus on are external doors, windows, cable and duct entry points. Due to the age and condition of the Main building this may account for up to 35% of heat loss. This is typically a low cost measure which can be undertaken by any competent builder.

An allowance for labour and materials of £4,000 is included in this report.

It was noted during the survey, the controls to the main entrance door were very sensitive, the automatic opening initiating from a long distance away leading to unnecessary openings. It is recommended the settings are altered to reduce the number of these occasions. In addition, repairs are required to ensure door closes fully.

Photo 5: Main automatic opening entrance doors

4.3 ROOF INSULATION

Typically, over 20% of heat in a building is lost through the roof. No above ceiling insulation was observed or reported in the main building; therefore, it is recommended to insulate the easily accessible areas with 300mm mineral wool insulation following careful removal of all debris and securing wiring. A lower embodied carbon material to rockwool is either sheep wool or hemp blanket, unfortunately, they come at a higher cost, therefore for this report, mineral wool will be used.

It is appreciated access to the roof voids is difficult, though there are several access hatches. The rooms with high ceilings will require a tower scaffold.

Photo 6: Roof void above Office RM 24.1 with no insulation

Photo 7: Example of an access hatch to a roof void in the Main building

The flat roof sections of the building are likely to have some insulation though well below current standards. Therefore, once the roof covering requires replacing, install PIR insulation to current building regs. As this isn't urgent, this measure isn't included in the analysis.

Photo 8: Example of a flat roof to the extension

Photo 9: Sloping ceiling to 2nd Floor Office in Extension

The extension pitched roof will have insulation between the rafters allowing for a full height ceiling below (see photo above). Insulated plasterboard could be added below improving the thermal properties, however, due to the amount of glazing present this would have minimal effect, therefore not recommended.

4.4 WINDOWS

The windows to the main building are single glazed sliding sash, mainly timber framed though some are metal framed. Aluminium secondary glazing units have been installed to some windows; the condition varies with draughts common. Due to the listed status, the original windows will need to remain and repaired/replaced as part of ongoing maintenance.

Photo 10: Example of a single glazed timber window with secondary glazing

Photo 11: Example of a metal framed single glazed window, no secondary glazing

Photo 12: Section of the front elevation showing different window types

Photo 13: Single glazed leaded window to stairs

For this decarbonisation study, the recommendation is to replace the secondary glazing units with new high performance units.

The windows to the 1990 extension are mainly double glazed aluminium or uPVC with a narrow air gap of around 6mm. Secondary glazing units have been installed to a few windows with integral blinds. In the recent Condition Survey[4], the recommendation was to replace the windows due to "loose handles, narrow air gaps, loose hinges with no restrictors".

This report supports the Condition Survey recommendation, the new windows to have a U-value of 1.6 W/m^{2}K or better. Consideration to be given to using solar control glass to limit solar gain in summer to reduce the requirement for cooling.

An initial analysis shows the works cannot be justified from a carbon saving viewpoint. Therefore, cannot be included in this Decarbonisation Plan. If the Condition Survey recommendation is implemented, heat loss will be reduced further resulting in lower energy bills, however, it is unlikely to change the proposed low carbon heating system.

Photo 14: Example of an original aluminium window

Photo 15: Example with secondary glazing with blind (Office 27)

4.5 EXTERNAL DOORS

Reference to the main entrance door is included in Section 4.2.

The double glazed external automatic doors to the Atrium are reported to be damaged and likely to require lifecycle replacement within 3 years. For the purposes of this report, the door seals to be repaired/replacement to reduce uncontrolled air infiltration.

Remaining doors are a mixture of single glazed or solid timber, uPVC or aluminium. Doors to be upgraded as part of condition replacement.

[4] Oakleaf, *Condition Survey for Council Offices*, September 2023

Photo 16: Entrance door to Atrium

The windows and doors to the Chamber and ancillary Rooms are newer with a wider air gap, these are satisfactory.

Photo 17: Close up of a Chamber Room door

4.6 SKYLIGHTS

The 1990 extension was constructed with large double glazed aluminium skylights to the second floor office space. The sealed units have failed and require replacement. The specification for the new units to have the lowest G-value possible to reduce heat loss. In addition, solar control glass to limit solar gain hence reducing the requirement for cooling in summer.

Once again, an initial analysis shows the works cannot be justified from a carbon saving viewpoint. Therefore, cannot be included in this Decarbonisation Plan.

Photo 18: Skylight to front elevation

Photo 19: Skylight to rear elevation

4.7 EXTERNAL WALLS

External walls can be insulated internally, externally or within cavities. External wall insulation is always preferable to internal, which, although an option, requires specialist advice to overcome potentially significant risks. As external wall insulation will change the aesthetic of the property and typically require planning permission, it is generally only considered as part of a major refurbishment, therefore, not considered as part of this study.

Installing cavity wall insulation is relatively simple, preferably with expanded polystyrene beads. Buildings with hard to treat cavity walls and where exposed to wind driven rain and where cavities are not completely clear should avoid cavity wall insulation. There is a risk that moisture can be carried through the wall and appear on the internal surface. There is also a risk of gaps being left, leading to cold spots and thus causing condensation damp and mould.

The 1990 extension will have cavity walls, though due to the age of the building, likely to be insulated. Therefore, no improvements are recommended.

4.8 GLAZED ATRIUM

The glazed atrium is a source of heat loss in winter and significant solar gain in summer. The recent Condition Survey Report states “evidence of blown double glazed seals and reports of water ingress. Requires replacement of affected units and investigation of water ingress including access equipment”.

In terms of heat loss, consideration to be given to the type of glass used in replacement units, reducing heat loss. The addition of a film will reduce solar gain.

An alternative, beyond the scope of this report, is to consider replacing the Atrium with a conventional structure, albeit a contemporary design. An example on a smaller scale has recently been completed by Westmorland and Furness (W&F) Council at their offices in Kendal.

Photo 20: W&F Council offices - before

Photo 21: W&F Council offices - after

4.9 LIGHTING UPGRADE

It was noted during the survey, some of the light fittings are the older fluorescent type. An upgrade to LED units would typically reduce the overall lighting consumption by around 50%. A further reduction can be made by upgrading the lighting controls to incorporate items such as occupancy detection, daylight dimming etc.

Photo 22: T8 suspended modular luminaire

Photo 23: Surface T8 luminaire and integral emergency

CALCULATION DETAILS

Floor	Area to be upgraded	Hours per Day	Days per Week	Hours per Annum	Comment
Basement	60	2	5	530	Some areas have LED panels already installed.
Ground Floor	1,322	10	5	2,600	Some areas have LED panels already installed.
First Floor	917	10	5	2,600	Some areas have LED panels already installed.
Second Floor	889	10	5	2,600	Some areas have LED panels already installed.

Table 8: Calculation details

The existing and proposed annual electricity consumption figures are based on fluorescent lighting at 0.016kW/m^2 and LED at 0.008kW/m^2. The proposed LED lighting will include PIR controls.

Floor	Fluorescent Lighting, Estimated Annual Electricity Consumption, kWh/annum	LED Lighting, Estimated Annual Electricity Consumption, kWh/annum
Basement	509	254
Ground Floor	56,053	28,026
First Floor	38,147	19,074
Second Floor	36,982	18,494
TOTAL	**131,691**	**65,846**

Table 9: Existing and proposed annual electricity consumption figures for lighting

POTENTIAL ENERGY AND CARBON SAVINGS OF PREFERRED OPTION

Based on the above the associated energy and carbon savings are **65,846kWh/annum** and **13,637kgCO_2/annum** respectively (based on 2023 grid electricity carbon emission factor of 0.2071kgCO_2e/kWh).

4.10 ADDITIONAL MEASURES

Measures with a short payback though hard to quantify are:

- Staff training in energy saving, setting operational targets, monitoring, and incentives.

This is an important measure and should be part of a Carbon Management Plan.

4.11 SUMMARY OF RECOMMENDED OPTIONS

Component	Proposal	Reason	Overall Impact to Carbon Reduction
Draughtproofing	Repair/replace door & window seals. Adjust main entrance door operation.	Reduce uncontrolled air infiltration	Medium
Roof insulation	Insulate roof voids to Main building with 300mm rockwool.	Improve U-value to 0.18 W/m^{2}K	Medium
Windows	Main building - Install high performance secondary glazing units.	Improve U-values to 1.6W/m^{2}K	Medium
Lighting	Replace all older type fluorescent tubes with LED	Reduce electricity consumption	High

Table 10: Recommended Energy Saving Measures

4.12 SOLAR PV

Due to the high existing electrical demand and anticipated future demand once heat pumps are installed, the proposal is to install as many solar PV panels as possible. As the building is Grade II listed, it is unlikely planning permission will be granted for PV panels which face the entrance, therefore, the focus is on the pitched roofs to the rear of the Extension and the adjacent flat roof.

Based on our initial assessment, a total installation of 40kWp could be installed (based on 430W panels). This is subject to a detailed simulation, a structural survey and permissions from the Planning Authority and DNO. The design layout of the panels will have to take into account the skylights. In addition, it is recommended the nearby tress have their crowns lowered to reduce shading or preferably, removed to eliminate shading.

The addition of battery storage could enable more of the electricity generated to be used within the building rather than exported. Due to the low level of exported generation, a battery is not considered.

Estimated annual CO_2 reduction is based on the future carbon emissions for grid electricity long-term marginal 2030 figure of 0.1kgCO_2e/kWh as stated in the DESNZ Treasury Green Book[5].

Based on current usage times and anticipated future electricity consumption, using the proprietary software, PV*SOL, the outputs are included in the table below:

[5] DESNZ, November 2023, Treasury Green Book supplementary appraisal guidance on valuing energy use and GHG emissions, Table 1.

Solar PV array size, kWp	Estimated Annual Generation, kWh	Electricity used within the building, kWh	Electricity exported to the Grid, kWh	Estimated Annual CO_2 Reduction, $kgCO_2$
40	39,920	39,816	104	3,982

Table 11: Solar PV Generation, Usage and Carbon Savings

Photo 8: Marked up Google Earth Image with potential PV Arrays in blue superimposed.

4.13 ECONOMIC MODELLING

An analysis of the proposed energy saving measures is included in Table 10 below. Cost estimates are based on quotations or recent project experience and can be used as budget figures. They include for contractor's prelims and overheads and profit at 15% and project management at 10%, however, exclude VAT.

- Draughtproofing – based on a Provisional Sum of £4,000.
- Pitched roof insulation – based on a cost of £25/m2.
- Secondary glazing to Main building – based on £250/m2.
- LED lighting – budget cost of £275,000.
- Solar PV - based on a cost of £1,000/kWp
- Energy Savings are based on electricity and gas tariffs of 33.5p/kWh and 10.8p/kWh respectively.

Measure	Estimated Capital Cost, £	P.F.[1]	Annual			Lifetime			Cost Per tonne of Lifetime CO_2 £/LTt	Simple Payback period, Years	Include in Decarb Plan?
			Energy Savings, kWh/Year	Carbon Savings tonnes CO_2/Year	Cost Savings, £/Year	Energy Savings, kWh	Carbon Savings tonnes CO_2	Cost Savings, £			
1. Draughtproofing	4,000	29.25	26,730	4.9	2,890	781,861	143.5	84,519	28	1	Yes
2. Roof insulation	12,500	27	37,780	6.9	4,084	1,020,052	187.2	110,268	67	3	Yes
3. Secondary glazing	38,143	7.92	24,376	4.5	2,635	193,062	35.4	20,870	1,077	14	Yes
4. LED Lighting	275,000	25	65,846	6.6	22,085	1,646,150	164.6	552,119	1,671	12	Yes
5. Solar PV	40,000	22.5	39,816	4.0	13,354	895,860	89.6	300,471	446	3	Yes
Total	**369,643**		**194,548**	**27**	**45,048**	**4,536,985**	**620**	**1,068,247**			

Table 12: Economic and Carbon Analysis of the Proposed Energy Saving Measures.

4.14 PEAK HEAT LOSS CALCUALTION

4.14.1 EXISITING BUILDING

The Salix Heat Loss Tool v1.2 has been used to produce a heat loss calculation.

	Value	Unit	Additional Information
Building Thermal Capacity ΣUA	8,658	W/K	
Volume of Space to be Heated by Heat Pump	12,311.15	m^3	
Air Changes per Hour	1.50	ACH	*Includes Occupancy Ventilation*
Ventilation Loss	6,156	W/K	
Heat Loss Coefficient	14,813	W/K	
U'	15	kW/K	
Winter Internal Setpoint Temperature	22.00	°C	
Winter Outdoor Design Temperature	-5.00	°C	
Peak Building Heat Loss	**399.96**	kW	

Table 13: Existing Peak Heat Loss Calculation

The U-values are based on the existing building fabric quoted in Table 2, the areas have been calculated from the drawings issued by the Council. The estimated peak heat loss is calculated to be 400kW.

4.14.2 PROPOSED BUILDING

The updated peak heat loss calculation considering the proposed energy saving measures is included below:

	Value	Unit	Additional Information
Building Thermal Capacity ΣUA	7,009	W/K	
Volume of Space to be Heated by Heat Pump	12,311.15	m^3	
Air Changes per Hour	1.50	ACH	*Includes Occupancy Ventilation*
Ventilation Loss	6,156	W/K	
Heat Loss Coefficient	13,165	W/K	
U'	13	kW/K	
Winter Internal Setpoint Temperature	22.00	°C	
Winter Outdoor Design Temperature	-5.00	°C	
Peak Building Heat Loss	**355.45**	kW	

Table 14: Peak Heat Loss Calculation Following Building Fabric Improvements.

The calculation shows a reduction in the peak heat loss from 400kW to 355kW.

5.0 LOW CARBON HEATING SYSTEMS

5.1 TECHNOLOGY OPTIONS CONSIDERED

The decarbonisation of the heating system can be achieved by the installation of a heat pump system. The heat pump options include Ground Source Heat Pumps (GSHP), horizontal (slinky) type and vertical (borehole type). Also, Air Source Heat Pumps (ASHP) which can either be an Air-to-Air type or Air-to-Water type.

With either type of Ground Source Heat Pumps, they require sufficient outdoor space for the installation of the pipework loops which extract the energy from the surrounding ground. The vertical type requires boreholes to be drilled into the ground to a nominal depth of 100m, a horizontal type requires the excavation of trenches approximately 2m deep by 2m wide.

For example, a peak heating load being 100kW. To satisfy this load, a borehole array would require a land area of 36m x 36m and a horizontal array would require a land area of 100m x 100m. In both cases the surrounding open ground around the Council Offices is not sufficient for a GSHP system.

An Air-to-Water heat pump system for this building involves linking a low operating temperature (50-55°C) heat pumps into the existing LPHW heating system. A lower operating temperature will result in the building taking longer to heat up, however, providing the energy saving measures are installed the system should satisfy demand without providing additional radiators. As the current gas fired boilers are the only fossil fuel powered plant remaining, their replacement is the main option for further decarbonisation of the mechanical services.

The main risk of considering Air-to-Water heat pumps would be noise from the outdoor units, impacting on both the residents and surrounding housing. A possible location of behind the plantroom has been identified. An acoustic enclosure may alleviate the noise levels; however, an acoustic consultant would need to be appointed as part of the planning application process.

An Air-to-Air heat pump system would require indoor fan coil type units with refrigerant pipework run to outdoor evaporator units, much like an air conditioning cooling system in reverse, each indoor unit would also require condensate piping to a suitable drain. If this is chosen to replace the boilers, the radiators and pipework would be redundant. There may also not be enough space for the installation of the accompanying indoor units to meet demand, which may alter the current installations.

The existing TP&N electricity supply may be adequate to supply a heat pump system, however a load test should be carried out prior to informing the electricity network provider of the increased electrical demand once a firm design is established.

A summary of the options is included in the following table below:

Technology	Description	Fuel Source	Space Required	CO_2 Reduction Potential	Reliability	Planning Issue	Suitability for Site	Recommendation
Heat Network	Heat networks supply heat from a central source via a network of underground pipes carrying hot water. Heat networks can cover a large area or a cluster of properties avoiding the need for individual boilers.	Dependent on Heat Network Operator	Existing Boiler Room could be converted to accommodate heat exchangers & controls.	Medium to High	Established System	Low Risk	Not currently feasible for the site due to no heat network in the vicinity	Currently Not Viable
Direct Electric Boiler	Direct electric boilers use electrical elements to directly heat water	Electricity	Can usually replace current Boiler Space	Medium	Newly refined technology available in various outputs	Low Risk	Not recommended for this site, more appropriate for smaller buildings due to higher running costs	No
Ground Source Heat Pumps - Boreholes	Energy extracted from the ground via deep (c.150m) boreholes.	Electricity	Large external space required.	Medium to High	Consistent performance throughout the year. Typical COP 3.5.	Low Risk	Insufficient land area available and not cost effective compared to other technologies	No
Ground Source Heat Pumps - Slinky	Energy extracted from the ground via horizontal pipes c.1.5 to 2m deep.	Electricity	Very large external space required.	Medium to High	Consistent performance throughout the year. Typical COP 3.5.	Low Risk	Insufficient land area available.	No

Air Source Heat Pump – Air-to-Water	Energy extracted from the external air to raise the temperature of a wet heating system. Typically provides a lower temperature heat (c.55ºC), usually requires larger/more radiators. However, can operate at 70ºC	Electricity	Small external area required	Medium to High	Established technology. Performance, COP, varies depending on the outdoor air temperature. Typical SCOP of 2.8 or 2.0 at high temps.	Medium risk due to being in residential and in a conservation area.	Could replace gas boilers, distribution pipework may need replacing along with the radiators.	Recommended
Air Source Heat Pump – Air-to-Air	Energy extracted from the external air to raise the temperature of the room air. Ability to provide cooling and heating. Typically serve ground or wall mounted units or ceiling cassettes.	Electricity	External area required for location of outdoor units. Flexibility in locating indoor units.	Medium to High	Established technology. Performance, COP, varies depending on the outdoor air temperature. Typical SCOP of 2.8.	Medium risk due to being in residential or in a conservation area.	Could replace gas boiler, however, refrigerant network installation is disruptive and new internal units required. Current pipework and radiators would become redundant, wasteful when there are other options.	Recommended

Table 15: Low Carbon Heating Options

5.2 ASSESSMENT OF CHOSEN OPTION

Based on the qualitative analysis above, which technology is recommended?

- As the existing gas fired boilers are over 10 years old, the recommendation is to replace the boiler with an Air-to-Water heat pump system; 8no. Mitsubishi CAHV 40kW. The obvious location for the heat pumps is preferably close to the Boiler Room.

What is the potential for a thermal storage?

- Potential to use the surplus electricity generated from the solar PV arrays for DHW modifying the existing system.

Would modifications to heat emitters be required for compatibility?

- None, the ASHP would operate at high temperatures, compatible with the existing distribution system.

Any red flags?

- Due to the Offices being close to a residential area and in a conservation area, a Noise Impact Assessment may be required as part of the planning application submission. In addition, careful location to minimise visual impact.
- A load test should be carried out to determine sufficient electrical capacity available.
- Approval required from the DNO for both the solar PV and heat pump installations

Any other opportunities?

- Addition of solar PV panels to generate electricity and help lower bills

6.0 ECONOMIC MODELLING

Cost estimates are based on recent project experience and can be used as budget figures. They include for contractor's prelims and overheads and profit at 15% and project management at 10%, however, exclude VAT.

Estimated capital cost of the hybrid Air-to-Water Heat Pump system is £300,000 (cost includes deduction for replacement of gas boilers as required for PSDS).

Installation of an ASHP to replace the gas boiler, energy saving measures undertaken first to reduce the heating demand, installation of solar PV.

Future carbon emissions for grid electricity are based on the long-term marginal 2030 figure of 0.1kgCO_2e/kWh.

Measure	Estimated Capital Cost, £	P.F.[6]	Annual			Lifetime			Cost per tonne of Lifetime CO_2, £/LTt	Simple Payback Period, Years
			Energy Savings, kWh/Year	Carbon Savings, tonnes CO_2e/Year	Cost Savings, £/Year	Energy Savings, kWh	Carbon Savings, tonnes CO_2e	Cost Savings, £		
Full ASHP System + Recommended Energy Saving Measures	£669,643	20	417,408	86	18,483	12,885,150	1,810	536,949	£370	N/A

Table 16: Economic and Carbon Analysis of the Proposed Energy Saving Measures and Low Carbon Heating System

[6] P.F. is the Persistence Factor for the ASHP taken from the Phase 3C PSDS Application Form V1.1

7.0 POSSIBLE HEAT PUMP LOCATIONS

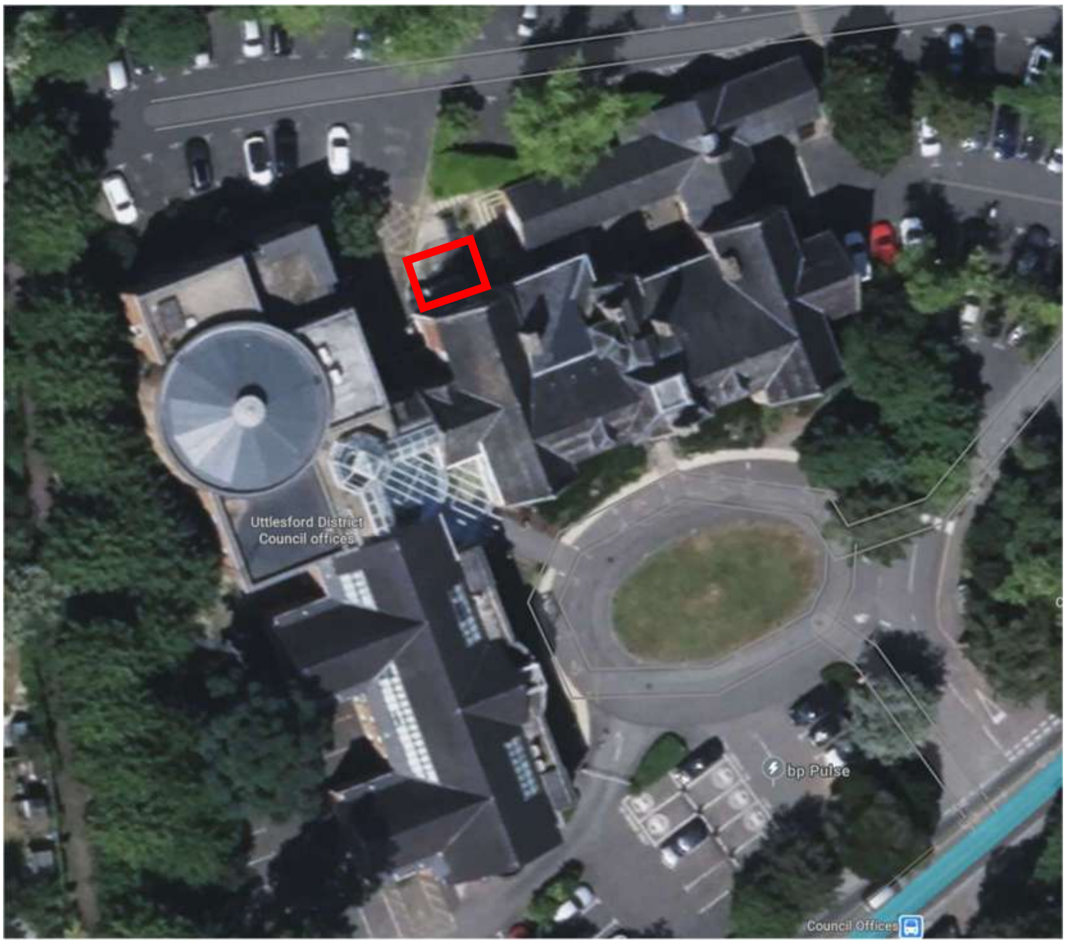

Figure 3: Potential Location of ASHP

8.0 LIFETIME CARBON SAVINGS

The estimated annual carbon savings for all the energy saving measures plus the new full heat pump system are 86tonnes CO_2 and the lifetime projects carbon savings are 1,810tonnesCO_2.

The estimated cost per tonne of lifetime CO_2e saved is £370/LTtCO_2e which is above last year's the Salix threshold of £325/ LTtCO_2e.

9.0 CONCLUSION

As stated throughout the process and illustrated within this report, a building fabric first approach has been taken.

Appropriate energy saving measures have been considered for the building and usage. Adopting all the proposed measures shows a reduction in the peak heat loss from 400kW to 355kW.

The recommended building fabric improvements plus the ASHP heating system have an estimated capital cost of £669,643 which results in a lifetime carbon saving cost of £370/LTtCO_2, above last year's Salix threshold figure of £325/LTtCO_2.

Following detailed design and firm pricing and review of the guidance to Phase 4 of the Public Sector Decarbonisation Scheme (PSDS), the economic and carbon analysis to be updated. Further discussion to be undertaken to finalise which energy saving measures are to be included in the application.

The installation of additional solar PV panels with an anticipated size of 40kWp would generate around 39,900kWh per year with virtually all used directly within the building helping to lower annual operating costs.

The waterfall chart below shows the stepped reduction in overall carbon emissions considering both fossil fuel usage and electrical usage. Current carbon emissions are based on a grid electricity emission factor of 0.207kgCO_2e/kWh, whereas future carbon emissions are based on the long-term marginal 2030 figure of 0.1kgCO_2e/kWh.

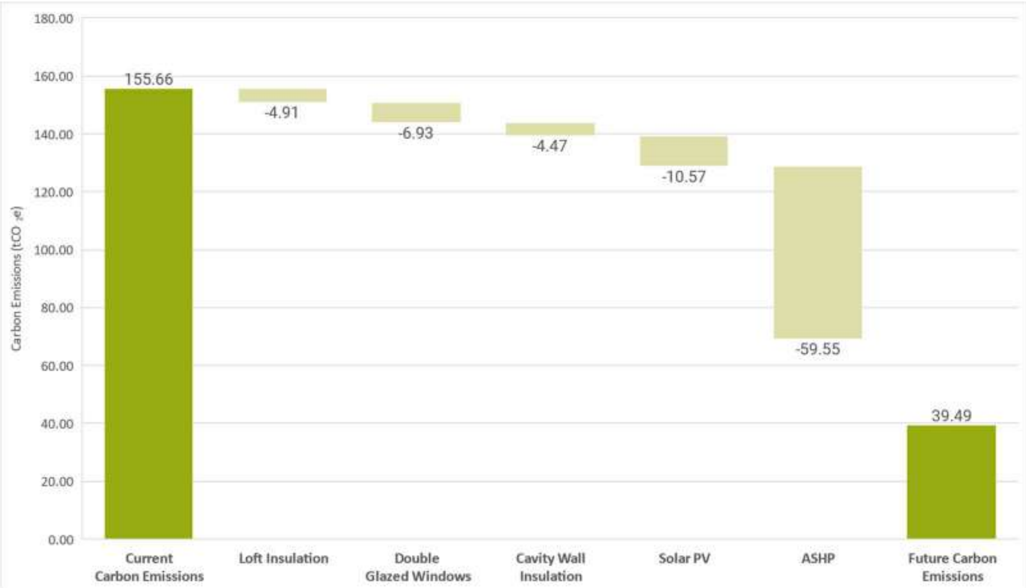

Figure 4: Waterfall Chart

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