REPORT FOR

GREAT MISSENDEN

PARISH COUNCIL

PREPARED BY

QUANTENERGY LTD

July 2022

CARBON FOOTPRINT
NET ZERO POTENTIAL
BIODIVERSITY BEST PRACTICE

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Contents

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Section 1: Carbon footprint

1.1 Carbon Footprint

Overview, concepts and methodology

The carbon footprint analysis has been conducted on the energy consumed by the buildings in scope, specifically the Great Missenden Memorial Centre, the Parish Office and the Prestwood Community Centre, and the energy consumed by the street lighting owned by the Great Missenden Parish Council. The scope of emissions analysed in this carbon footprint reflect the guidelines of the Greenhouse Gas Protocol, which sets international standards for carbon accounting in the private and public sector. To this extent the targeted emissions analysed fall into the categories of scope 1 and 2 emissions. Scope 1 emissions refers to direct emissions that are owned or controlled by the organisation, for example emissions from combustion of boilers. Scope 2, instead, considers emissions from the generation of purchased electricity that has been consumed by the company[1]. The primary data sources used are at least one year of gas and electricity invoices that contain information about the energy used. The energy consumption has been converted into Carbon (CO2) emissions using UK national conversion factors published by the Department for Business, Energy, and Industrial Strategy (BEIS), the Government department administering the energy sector.

When calculating gas CO2 emissions an important concept to understand is the net calorific value. The Net calorific value (NCV) is determined by subtracting the heat of vaporisation of the water vapour from the higher heating value. In simple words, the NCV represents the amount of actual usable energy. The BEIS conversion factor used to calculate the carbon footprint of gas usage is Natural Gas, expressed in kWh and NCV. The figure used for the conversion factor is the latest available from BEIS, is expressed in kg of CO2, it refers to the year 2021 and has been revised in January 2022.

Moving to carbon emissions generated by electricity consumption, some electricity suppliers provide a percentage of renewable energy. The renewable electricity component of the fuel mix of energy suppliers is determined by the number of Renewable Energy Guarantees of Origin (REGOs) that they have acquired. The company Bulb, which supplies electricity to the Memorial Hall building, claims to supply 100% renewable electricity, based on the REGOs certificates it has acquired. However, once the electricity generated from whichever source is injected into the grid and used by the end user, it is almost impossible to discern which electricity is produced by renewables or other sources. Therefore, when calculating the carbon footprint from electricity generation, it is useful to use the BEIS conversion factors. Those are regularly updated to reflect the proportion of the various energy sources composing the UK national energy mix. Based on the BEIS guidelines, for reporting contexts where specific scopes do not need to be reported the 'electricity consumption' figure can be calculated by adding together the 'electricity generation' and the 'Transmission and Distribution' (T&D) values within each year. Both BEIS conversion figures used in this analysis convert kWh in kg CO2, they refer to the year 2021 and have been revised in January 2022. The next paragraph will provide detailed information about the carbon footprint analysis.

[1] Reference: https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf. Page 25.

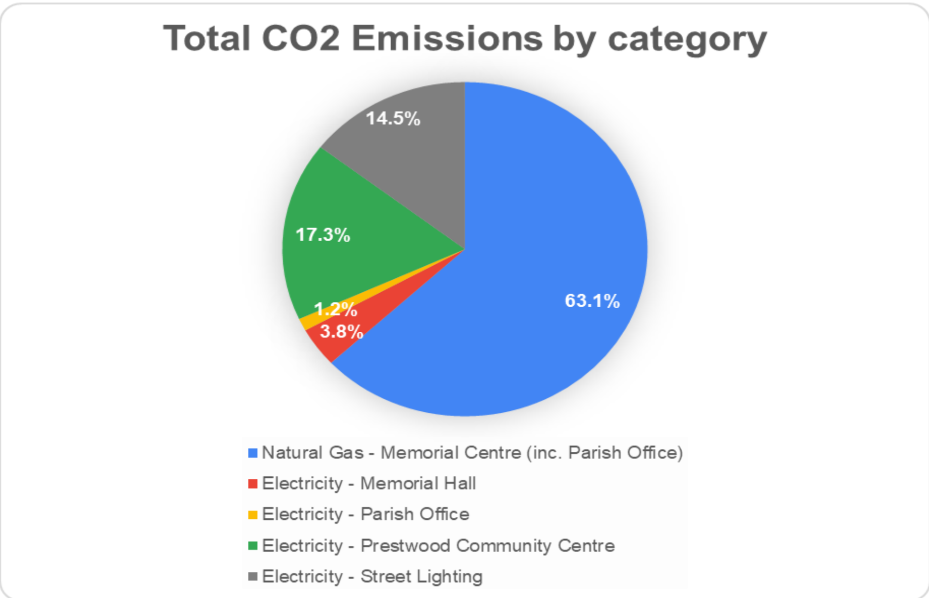
1.2 Carbon Footprint Results

Based on the energy data received, the total consumption of the categories in scope amounts to **162,426 kilowatt hours** (kWh). This translates to **34.36 tonnes of carbon dioxide** (tCO_2) emissions. Table 1 provides a breakdown of the category identified, the scope, the period covered, total energy consumption and total carbon emissions. Figure 1 presents the same categories and carbon emissions figures of Table 1. The highest CO_2 emissions are from gas usage at Great Missenden Memorial Centre (63.1%), followed by the electricity consumed at Prestwood Community Centre (17.3%) and the electricity used for street lighting (14.5%). For a more detailed breakdown of the data used, energy consumption and carbon emissions see tables in Appendix I.

Table 1 - Summary of calculated emissions by category

Category	Scope	Year	Total consumption (kWh)	Total emissions tCO2
Natural Gas - Memorial Centre (inc. Parish Office)	1	2021-22	106,999	21.68
Electricity - Memorial Hall	2	2021-22	5,753	1.32
Electricity - Parish Office	2	2021-22	1,812	0.42
Electricity - Prestwood Community Centre	2	2021-22	26,032	5.96
Electricity - Street Lighting	2	2021	21,829	4.99
Total			**162,425**	**34.36**

Figure 1 - Total CO2 emissions by category



1.3 Energy Benchmarking

CISBE energy benchmark parameters for Prestwood Community & Youth Centre

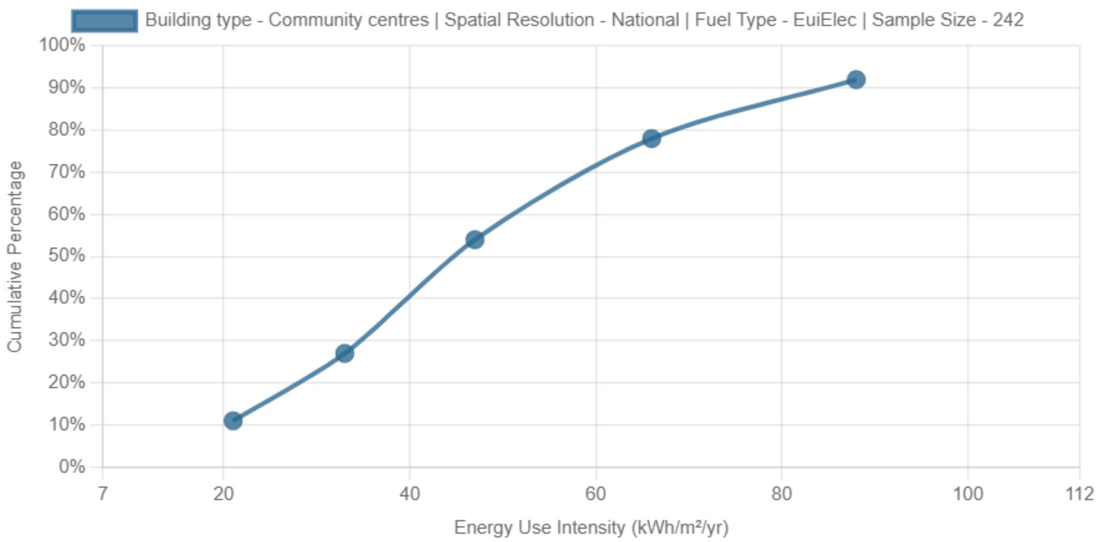
Table 2 - CISBE energy consumption benchmark Electricity - Community Centres (Prestwood Community & Youth Centre)

Prestwood Community & Youth Centre Floor area (m^2)	Annual consumption Prestwood Community & Youth Centre (kWh)	Annual consumption Prestwood Community & Youth Centre ($kWh/m^2/year$)	Good Practice Electricity ($kWh/m^2/year$)	Typical practice Electricity ($kWh/m^2/year$)
130	26,032	200	33	47

Source: https://www.cibse.org/knowledge-research/knowledge-resources/knowledge-toolbox/energy-benchmarking-tool

The performance of the Prestwood Community Centre is circa 4 times worse than the expected typical practice benchmarks for similar community buildings in the UK.

Figure 2 - CISBE energy consumption benchmark Electricity -Community Centres (Prestwood Community & Youth Centre)



Building Type	Good practice electricity	Typical practice electricity	Source
Community centres	33	47	DEC

Showing 1 to 1 of 1 entries

* Energy consumption benchmarks for existing buildings in $kWh/m^2/yr$ unless stated otherwise

CISBE energy benchmark parameters for Memorial Centre, including Parish Office

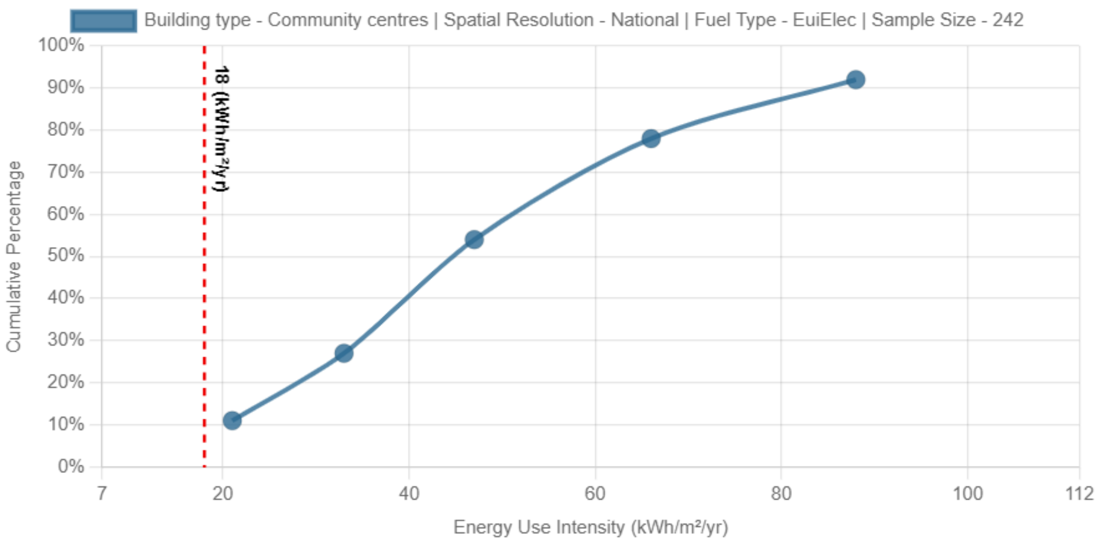
Table 3 - CISBE energy consumption benchmark - Electricity - Community Centres (Memorial Centre - including Parish Office)

Memorial Centre (inc. Parish Office) Floor area (m²)	Annual consumption Prestwood Community & Youth Centre (kWh)	Annual consumption Prestwood Community & Youth Centre (kWh/m²/year)	Good Practice Electricity (kWh/m²/year)	Typical practice Electricity (kWh/m²/year)
411	7385.6	18	33	47

Source: https://www.cibse.org/knowledge-research/knowledge-resources/knowledge-toolbox/energy-benchmarking-tool

The electricity performance of the Memorial Centre is better than the good practice benchmark for UK buildings of a similar function.

Figure 3 - CISBE energy consumption benchmark Gas community centres (Memorial Centre - including Parish Office)



Building Type	Good practice electricity	Typical practice electricity	Source
Community centres	33	47	DEC

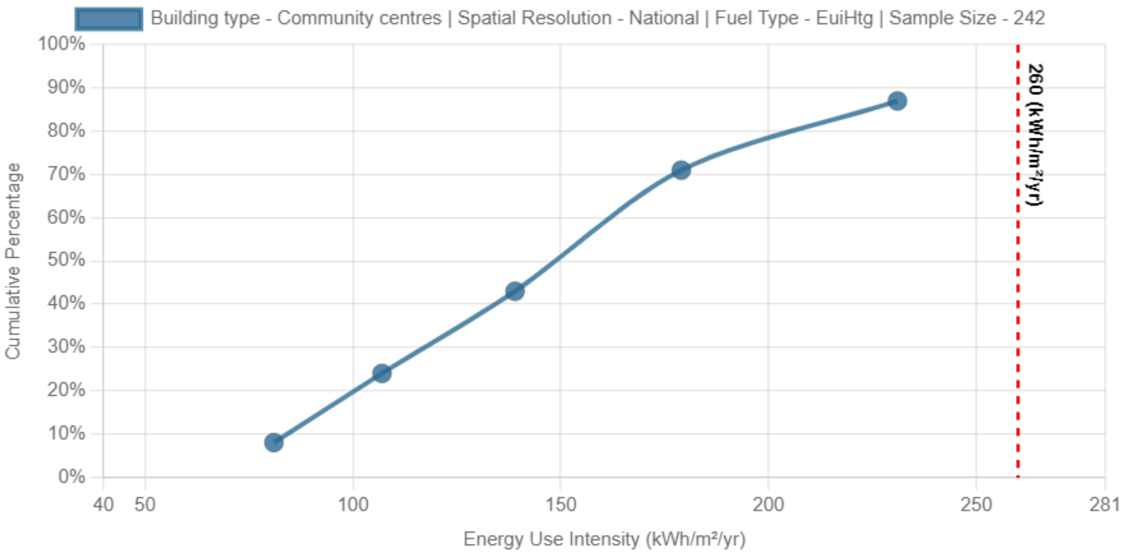
Table 4 - CISBE energy consumption benchmark, Gas - Community Centres (Memorial Centre - including Parish Office)

Memorial Centre (inc. Parish Office) Floor area (m²)	Annual consumption Prestwood Community & Youth Centre (kWh)	Annual consumption Prestwood Community & Youth Centre (kWh/m²/year)	Good Practice Electricity (kWh/m²/year)	Typical practice Electricity (kWh/m²/year)
411	106,999.76	260	107	139

Source: https://www.cibse.org/knowledge-research/knowledge-resources/knowledge-toolbox/energy-benchmarking-tool

The gas performance of the Memorial Centre, however, is about 2 X worse than the typical practice benchmark for similar buildings in the UK.

Figure 4 - CISBE energy consumption benchmark Gas community centres



Building Type	Good practice fossil fuels	Typical practice fossil fuels	Source
Community centres	107	139	DEC

Showing 1 to 1 of 1 entries

* Energy consumption benchmarks for existing buildings in kWh/m²/yr unless stated otherwise

Section 2: Energy Audit and Net Zero Potential

The energy audit was conducted on 27 May 2022, and it comprised of the survey of two buildings: the Great Missenden Memorial Centre, which included the Memorial Hall facility and the Parish office, and the Prestwood Community Centre.

The audit covered the following aspects:

- Interview with Jane Hennessey, who completed the two survey forms collecting information about the buildings and provided additional information about street lighting and the fields owned by Great Missenden Parish Council (GMPC).
- Walk around the Memorial Centre and Prestwood Community Centre facilities as well as the allotments space adjacent to the Prestwood community Centre.
- Pictures taken of gas and electricity meters, gas boilers, wet radiators, electric heaters, roofs inclination, flood lights, indoor lighting and outdoor parking space.
- Energy invoices and meter data were collected for analysis

Modelling Assumptions

Data Analysis and Modelling of historical energy consumption and energy invoices has been undertaken, as the basis of detailed modelling and predictions for low carbon technologies. Using our investment optimisation algorithms, we have modelled the different permutations of the following low carbon technologies:

a. Solar Photovoltaic
b. Heat Pumps
c. Battery Storage
d. Electric Vehicle charging (infrastructure)

Detailed structural and electrical infrastructure analysis has not been included at this stage and it is recommended that this is carried out prior to undertaking any installation works.

See Appendix 2 for the detailed set of assumptions used for the modelling.

From the audit conducted, several energy efficiency opportunities have been identified. These are presented in the sections below.

2.1 Prestwood Youth and Community Centre

1. **Installation of Smart Meters** - There is one electric meter on site. Smart meters have not been installed. These are available for both gas and electricity, provide near real-time information on energy use, enabling better management of energy consumed and potential cost and carbon savings. Another benefit is that smart meters communicate directly with the energy supplier so that there is no need for manual readings and the bills are accurate based on actual energy consumption rather than estimated. It is important to install SMETS 2 smart meter types which will continue to work even if the utility supplier has changed (as opposed to the previous generation - SMETS 1 – that stopped communicating if there was a switch to another energy supplier). There is no upfront cost for the installation of such meters, the cost has already been socialised in every energy bill, whether

one has installed a smart meter or not. The installation can be carried out by the energy supplier, often upon request.

2. **Roof insulation** - The current insulation thickness (visually estimated due to lack of access into roof space) is between 80mm and 100 mm. The current building regulations require that loft insulation should be at least 270 mm thick and must have good thermal properties. It is recommended that the insulation be upgraded to the new standards to reduce heat loss from the roof, energy consumption and utility costs. Insulation upgrades can reduce energy consumption by circa 8%.

3. **Windows** - The visual inspection of window glazing suggests that the windows could benefit from upgrading to high performance double glazing. Based on the visual appraisal of the overall building fabric, we recommend that the upgrade of windows glazing be undertaken at a later stage to align with wider building and fabric refurbishments in the future. As this is a modular construction, changing the windows out may prove to be a challenge, so we have excluded this from our modelling.

4. **Lighting** - The current indoor lighting are neon lamp tubes: 8 neon lamps (x2 tubes) located in the main hall, 1 neon lamp (1 tube) in the entrance hall, 3 rooms with 1 neon lamp (1 tube). To improve energy efficiency, it is recommended that these be replaced with LED technology. This could enable a 1.4% reduction in carbon emissions, see Appendix 3 for calculations on potential savings.

5. **Heating** - 5 electric heaters of 2 kW consumption each, wall mounted were present on site. Two of them have adjustable heating intensity. The modelling of air source heat pumps to replace the current electric heaters demonstrates a potential carbon savings of 45.7%. See options analysis below. See Appendix 4 for details on types of heat emitters for air source heat pumps and product vendors.

6. **Solar PV**
   a. **Roof mounted solar PV -** southeast facing. There is potential for solar PV generation to reduce grid reliance and carbon emissions. However, before committing to any installation it is strongly advised to conduct a feasibility study assessing a complete structural analysis of the roof for loading impacts.

   b. **Ground mounted solar PV** - adjoining allotments. There is potential for solar PV generation in the unused area in the allotments for ground mounted solar system, no loading impact evaluation is needed, but shading from the trees adjacent to the space identified may impede on solar generation.

7. **EV charging -** In the car parking space next to the building there are 14 to 16 car parking spaces available. Our modelling is based on the potential to install 1 x dual charging point at this stage, which will cover 2 parking spaces at this stage. Further EV chargepoint deployments would need to be considered later to cater for the wider uptake in electric vehicles in the country.

We have modelled 7KW electric vehicle (EV) fast charging units in mode 3. In Mode 3, EVs are charged using a specific apparatus, known as EV charging station, which is permanently connected to an AC power supply system. This apparatus allows higher power choice and therefore faster charging rates compared to mode 1 and 2, ranging from 3.7kW to 22kW AC. Charging speed of 7 kW allows to charge a standard EV in about 8 hours[2]. These chargers work typically with single phase power supply, which is aligns with the electrical infrastructure on site. Another reason for opting to this charging speed is that currently most EVs have an onboard charger up to 6.6 kW, therefore the EV charging unit is not oversized for the specifications of a typical vehicle in the market today.

8. **<u>Electric Storage Battery</u>** – We have modelled the viability of installing electric battery storage systems coupled with the Solar PV installations, in conjunction with Heat Pumps and EV chargers to store unused Solar PV for use within the building to drive higher levels of carbon reduction.

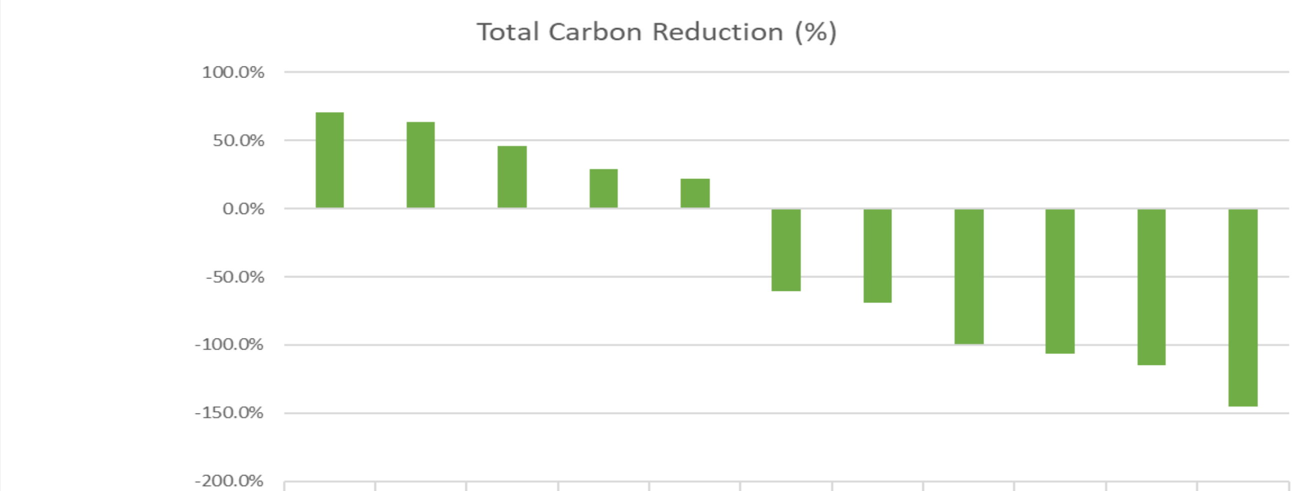
See Options Analysis below for the various modelled permutations of technologies, their potential for carbon reduction, investment, and savings.

Options analysis

The modelling results and recommended low carbon technologies for each building are set out below:

A. Prestwood Community Centre: Roof Mounted Solar PV

The following modelling options results are for a roof mounted Solar PV system couple with the other technologies. The results of the various permutations analysed have been presented in descending order starting from the highest level of carbon reduction achievable. <u>The Net Zero potential for the building is 70.4% with Solar PV, Heat Pumps and Battery Storage for a budget investment of £33,846.</u>

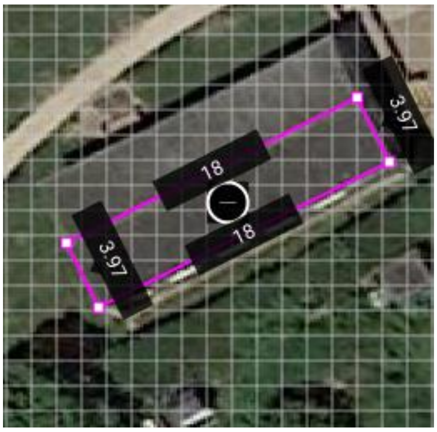


Battery Storage	yes	-	-	yes	-	yes	-	-	yes	-	-
EV Chargers	-	-	-	-	-	yes	yes	yes	yes	yes	yes
Heat Pumps	yes	yes	yes	-	-	yes	yes	yes	-	-	-
Solar PV	yes	yes	-	yes	yes	yes	yes	-	yes	yes	-
Total Carbon Reduction (%)	70.4%	63.3%	45.7%	29.1%	21.7%	-60.5%	-69.4%	-99.6%	-106.2%	-115.1%	-145.3%

[2] Reference: https://pod-point.com/guides/driver/how-long-to-charge-an-electric-car#:~:text=The%20time%20it%20takes%20to,with%20a%207kW%20charging%20point.

	Solar PV	Heat Pump	EV Chargers	Battery Storage	Annual Electricity Consumption (kWh)	Annual Gas Conumption (kWh)	Total Energy Consumption (kwh)	Electricity Carbon Emissions (kgCO2)	Gas Carbon Emissions (kgCO2)	Total Carbon Emissions (kgCO2)	Total Carbon Reduction (%)	Annual Electricity Cost (£)	Annual Gas Cost (£)	Total Energy Cost (£)	Annual Energy Cost Savings (£)	Budget Investment	Payback (Years)
Baseline	-	-	-	-	15,266	-	15,266	3,492	-	3,492	0.0%	£ 2,641	£ -	£ 2,641	£ -		
1	yes	yes	-	yes	4,519	-	4,519	1,034	-	1,034	70.4%	£ 709	£ -	£ 709	£ 1,931	£ 33,846	18
2	yes	yes	-	-	5,606	-	5,606	1,282	-	1,282	63.3%	£ 880	£ -	£ 880	£ 1,760	£ 28,800	16
3	-	yes	-	-	8,288	-	8,288	1,896	-	1,896	45.7%	£ 1,301	£ -	£ 1,301	£ 1,339	£ 8,790	7
4	yes	-	-	yes	10,821	-	10,821	2,475	-	2,475	29.1%	£ 1,699	£ -	£ 1,699	£ 942	£ 27,308	29
5	yes	-	-	-	11,954	-	11,954	2,735	-	2,735	21.7%	£ 1,877	£ -	£ 1,877	£ 764	£ 20,010	26
6	yes	yes	yes	yes	24,505	-	24,505	5,606	-	5,606	-60.5%	£ 3,847	£ -	£ 3,847	-£ 1,207	£ 37,878	-31
7	yes	yes	yes	-	25,858	-	25,858	5,915	-	5,915	-69.4%	£ 4,060	£ -	£ 4,060	-£ 1,419	£ 31,575	-22
8	-	yes	yes	-	30,471	-	30,471	6,970	-	6,970	-99.6%	£ 4,784	£ -	£ 4,784	-£ 2,143	£ 11,565	-5
9	yes	-	yes	yes	31,483	-	31,483	7,202	-	7,202	-106.2%	£ 4,943	£ -	£ 4,943	-£ 2,302	£ 29,088	-13
10	yes	-	yes	-	32,836	-	32,836	7,512	-	7,512	-115.1%	£ 5,155	£ -	£ 5,155	-£ 2,515	£ 22,785	-9
11	-	-	yes	-	37,449	-	37,449	8,567	-	8,567	-145.3%	£ 5,879	£ -	£ 5,879	-£ 3,239	£ 2,775	-1

The Solar PV installation modelled is roof mounted on the SE facing aspect of the pitch roof (see image).



All permutations modelled above include energy and carbon reduction achieved through roof insulation and upgrades in lighting to LED.

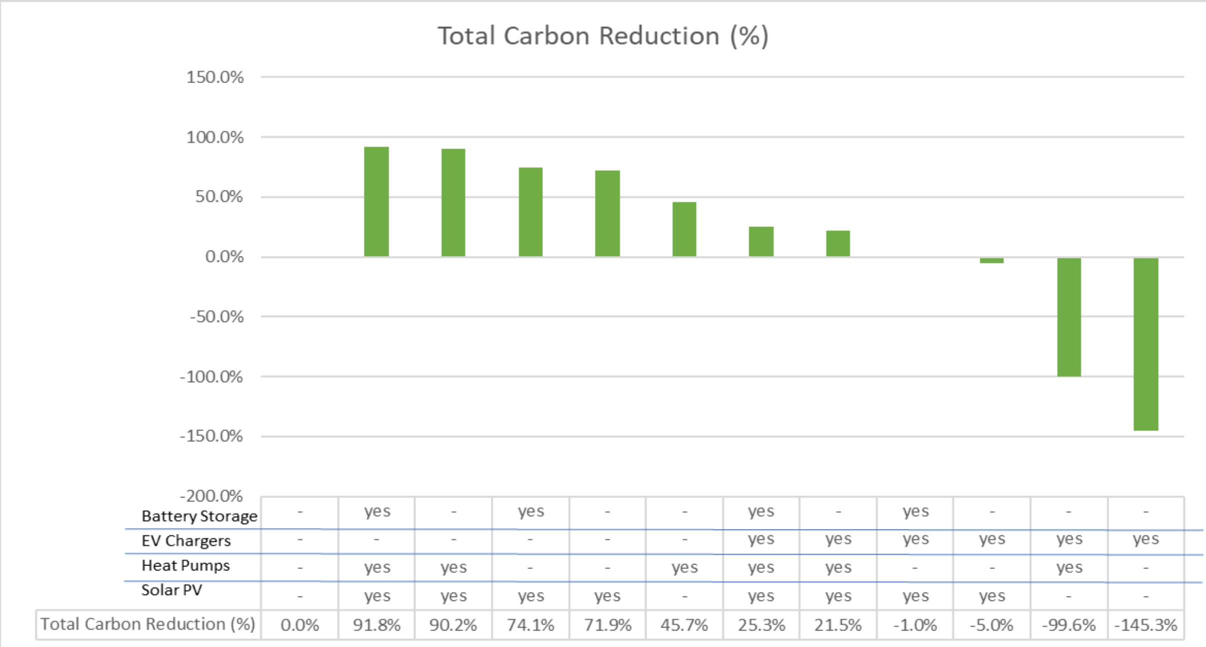
Also note that emissions reductions from EV Chargers through petrol & diesel carbon reduction not included at this stage in the modelling, hence the negative carbon emissions associated with the installation and use of the EV chargers in the table above.

It has been assumed at this stage that all the energy costs associated with the charging of electric vehicles would be borne by the Parish Council and not passed on to the consumer, hence the negative cost savings associated with the EV charging options in the table above. This requires further investigation into the various business and commercial models in the industry that enable investment in EV charging, provide management of the systems, including smart charging, and commercially manage the relationship (including cost of charging) with the end user / public.

B. Prestwood Community Centre: Ground Mounted Solar PV

The following modelling options results are for a roof mounted Solar PV system. The results of the various permutation analyses have been presented in descending order starting from the highest level of carbon reduction achievable.

The Net Zero potential for the building is 91.8% with Solar PV, Heat Pumps and Battery Storage for a budget investment of £47,460.



	Solar PV	Heat Pump	EV Chargers	Battery Storage	Annual Electricity Consumption (kWh)	Annual Gas Conumption (kWh)	Total Energy Consumption (kwh)	Electricity Carbon Emissions (kgCO2)	Gas Carbon Emissions (kgCO2)	Total Carbon Emissions (kgCO2)	Total Carbon Reduction (%)	Annual Electricity Cost (£)	Annual Gas Cost (£)	Total Energy Cost (£)	Annual Energy Cost Savings (£)	Budget Investment	Payback (Years)
Baseline	-	-	-	-	15,266	-	15,266	3,492	-	3,492	0.0%	£ 2,641	£ -	£ 2,641	£ -	-	-
1	yes	yes	-	yes	1,247	-	1,247	285	-	285	91.8%	£ 196	£ -	£ 196	£ 2,445	£ 47,460	19
2	yes	yes	-	-	1,503	-	1,503	344	-	344	90.2%	£ 236	£ -	£ 236	£ 2,405	£ 41,910	17
3	yes	-	-	yes	3,953	-	3,953	904	-	904	74.1%	£ 621	£ -	£ 621	£ 2,020	£ 41,624	21
4	yes	-	-	-	4,284	-	4,284	980	-	980	71.9%	£ 673	£ -	£ 673	£ 1,968	£ 33,120	17
5	-	yes	-	-	8,288	-	8,288	1,896	-	1,896	45.7%	£ 1,301	£ -	£ 1,301	£ 1,339	£ 8,790	7
6	yes	yes	yes	yes	11,404	-	11,404	2,609	-	2,609	25.3%	£ 1,790	£ -	£ 1,790	£ 850	£ 50,565	59
7	yes	yes	yes	-	11,990	-	11,990	2,743	-	2,743	21.5%	£ 1,882	£ -	£ 1,882	£ 758	£ 44,685	59
8	yes	-	yes	yes	15,417	-	15,417	3,527	-	3,527	-1.0%	£ 2,420	£ -	£ 2,420	£ 220	£ 43,193	196
9	yes	-	yes	-	16,023	-	16,023	3,665	-	3,665	-5.0%	£ 2,516	£ -	£ 2,516	£ 125	£ 35,895	287
10	-	yes	yes	-	30,471	-	30,471	6,970	-	6,970	-99.6%	£ 4,784	£ -	£ 4,784	-£ 2,143	£ 11,565	-5
11	-	-	yes	-	37,449	-	37,449	8,567	-	8,567	-145.3%	£ 5,879	£ -	£ 5,879	-£ 3,239	£ 2,775	-1

The Solar PV installation modelled is ground mounted located in the fallow / unused area of the adjacent allotments (see image).
All permutations modelled above include energy and carbon reduction achieved through roof insulation and upgrades in lighting to LED.

Also note that emissions reductions from EV Chargers through petrol & diesel carbon reduction not included at this stage in the modelling, hence the negative carbon emissions associated with the installation and use of the EV chargers in the table above.

It has been assumed at this stage that all the energy costs associated with the charging of electric vehicles would be borne by the Parish Council and not passed on to the consumer, hence the negative cost savings associated with the EV charging options in the table above. This requires further investigation into the various business and commercial models in the industry that enable investment in EV charging, provide management of the systems, including smart charging, and commercially manage the relationship (including cost of charging) with end users.

2.2 Great Missenden Memorial Centre

1. **Smart Meters** - There are two electric meters on site, connected respectively to the Memorial Hall building and to the Parish office. One main gas meter supplies the entire facility, and there is a sub meter installed for gas that monitors usage in the Parish Office. Smart meters are not present on site, therefore similar considerations drawn for the Prestwood Community Centre about the installation of smart meters apply also for this building, Parish office included.

2. **Windows and general building fabric** - From a visual inspection, window glazing and building fabric appears in good in good condition, as there was recent investment in upgrading and refurbishing the buildings.

3. **Lighting** - The current lighting in the Memorial Hall building are ceiling lights, from the visual inspection it was not possible to check the type of lamp currently in use. However, as the Memorial Hall was recently refurbished, we have assumed that the lights were also upgraded to LED. If this is not the case, it is recommended to replace all lights with LED technology, which is currently one of the most energy efficient solution for lighting.

4. **Heating** - In the Parish Office building is present one boiler, brand Viessmann, size 26 kw, 4 years old. In the Memorial Hall building is present one boiler, brand Viessmann, size 66 kw, installation date unknown. These are relatively new and have at least another 10-12 years of useful life in them. Whilst we have modelled the switch-over to Heat Pumps, we recommend that these boilers be upgraded at the end of each boiler's life for a more sustainable solution.

5. **Solar -** Roof installation - west facing. There is potential for solar PV generation to reduce grid reliance and carbon emissions. However, before committing to any installation it is strongly advised to conduct a feasibility study assessing a complete structural analysis of the roof for loading impacts.

6. **EV charging** - 16 car parking spaces are available on site. Following the considerations made for the Memorial Centre, there is potential to install 1 x dual charging point at this stage, which will cover 2 parking spaces. We have modelled 7KW EV fast charging, mode 3. Further EV chargepoint deployments would need to be considered later to cater for the wider uptake in electric vehicles in the country.

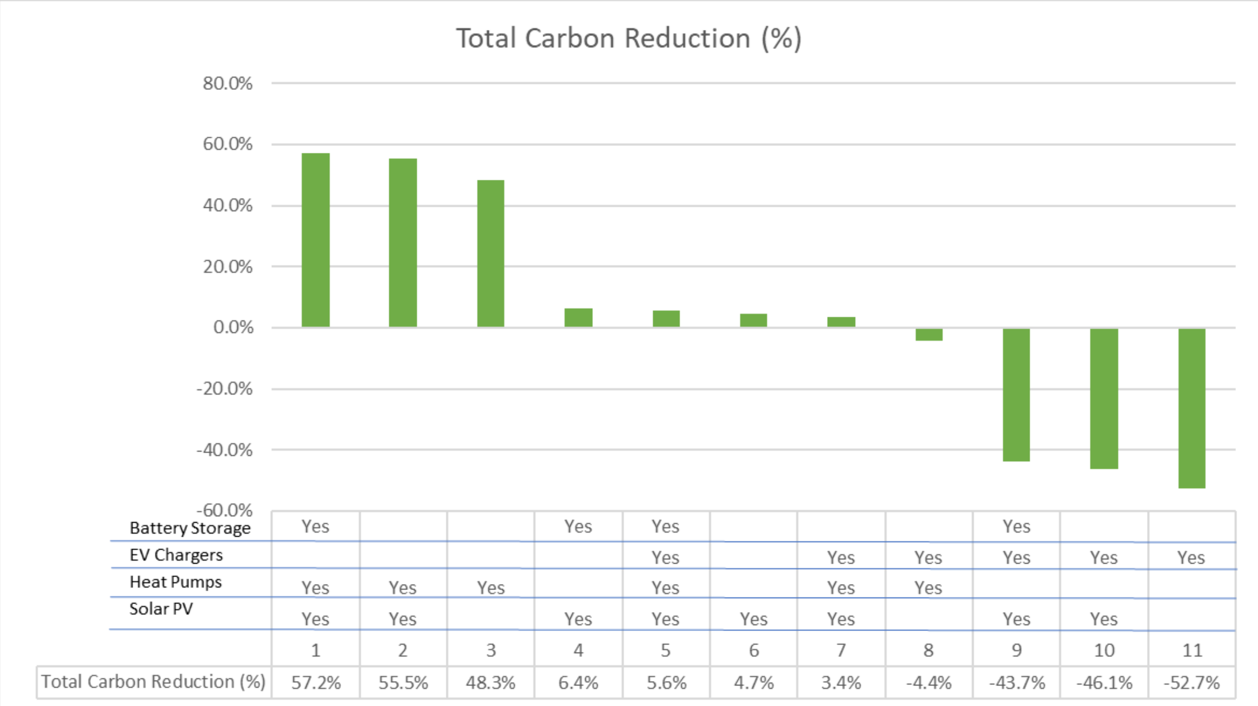
7. **Electric Storage Battery** - We have modelled the viability of installing electric battery storage systems coupled with the Solar PV installations, in conjunction with Heat Pumps and EV chargers to store unused Solar PV for use within the building to drive higher levels of carbon reduction.

   See options analysis below for the various modelled permutations of technologies, their potential for carbon reduction, investment, and savings.

Options analysis

The modelling results and recommended low carbon technologies for each building are set out below: The following modelling options results are for a roof mounted Solar PV system. The results of the various permutation analyses have been presented in descending order starting from the highest level of carbon reduction achievable.

The Net Zero potential for the building is 57.2% with Solar PV, EV Chargers and Battery Storage for a budget investment of £36,920



	Solar PV	Heat Pump	EV Chargers	Battery Storage	Annual Electricity Consumption (kWh)	Annual Gas Conumption (kWh)	Total Energy Consumption (kwh)	Electricity Carbon Emissions (kgCO2)	Gas Carbon Emissions (kgCO2)	Total Carbon Emissions (kgCO2)	Total Carbon Reduction (%)	Annual Electricity Cost (£)	Annual Gas Cost (£)	Total Energy Cost (£)	Annual Energy Cost Savings (£)	Budget Investment	Payback (Years)
Baseline	-	-	-	-	6,661	67,863	74,524	1,524	13,748	15,271		£ 1,548	£ 3,011	£ 4,559	-	-	-
1	Yes	Yes		Yes	22,531	6,786	29,318	5,154	1,375	6,529	57.2%	£ 5,986	£ 301	£ 6,287	-£ 1,728	£ 36,920	-21
2	Yes	Yes			23,715	6,786	30,501	5,425	1,375	6,800	55.5%	£ 6,227	£ 301	£ 6,528	-£ 1,969	£ 29,622	-15
3		Yes			28,513	6,786	35,300	6,523	1,375	7,897	48.3%	£ 7,276	£ 301	£ 7,577	-£ 3,017	£ 15,132	-5
4	Yes			Yes	2,365	67,863	70,228	541	13,748	14,289	6.4%	£ 611	£ 3,011	£ 3,622	£ 938	£ 22,994	25
5	Yes	Yes	Yes	Yes	56,984	6,786	63,771	13,036	1,375	14,411	5.6%	£ 14,140	£ 301	£ 14,441	-£ 9,882	£ 40,814	-4
6	Yes				3,525	67,863	71,389	806	13,748	14,554	4.7%	£ 864	£ 3,011	£ 3,875	£ 685	£ 14,490	21
7	Yes	Yes	Yes		58,472	6,786	65,258	13,376	1,375	14,751	3.4%	£ 14,440	£ 301	£ 14,741	-£ 10,182	£ 32,397	-3
8		Yes	Yes		63,681	6,786	70,468	14,568	1,375	15,942	-4.4%	£ 15,562	£ 301	£ 15,864	-£ 11,304	£ 17,907	-2
9	Yes		Yes	Yes	35,806	67,863	103,670	8,191	13,748	21,939	-43.7%	£ 8,554	£ 3,011	£ 11,565	-£ 7,006	£ 25,682	-4
10	Yes		Yes		37,464	67,863	105,327	8,570	13,748	22,318	-46.1%	£ 8,901	£ 3,011	£ 11,912	-£ 7,353	£ 17,265	-2
11			Yes		41,829	67,863	109,692	9,569	13,748	23,316	-52.7%	£ 9,833	£ 3,011	£ 12,844	-£ 8,285	£ 2,775	0

Initial modelling for Solar PV included all SW facing sections of the flat and pitched roofs, which yielded solar potential that vastly exceeded the building demand and would subsequently export the majority to the grid. The returns from grid export tend to be low now, usually between 3 and 5 p/kWh, thereby not making a return on the high upfront cost. This was subsequently optimised to Roof 3 only, for a smaller PV system, for investment reduction and maximising solar self-consumption for highest decarbonisation potential.

Also note that emissions reductions from EV Chargers through petrol & diesel carbon reduction not included at this stage in the modelling, hence the negative carbon emissions associated with the installation and use of the EV chargers in the table above.

It has been assumed at this stage that all the energy costs associated with the charging of electric vehicles would be borne by the Parish Council and not passed on to the consumer, hence the negative cost savings associated with the EV charging options in the table above. This requires further investigation into the various business and commercial models in the industry that enable investment in EV charging, provide management of the systems, including smart charging, and commercially manage the relationship (including cost of charging) with end users.

2.3 Street Lighting

The total number of streetlights in the Parish Council is 71. Most of them are sodium lamps, 22 lamps have been replaced with LED models. It is recommended to continue with the replacement of all remaining lamp with LED models, and if it is physically possible and reasonably cost effective, change the electricity supply of street lighting from unmetered to metered, this should be done because most of the streetlights are already equipped with photocells that switch on the lamp at dusk and turn it off at dawns, therefore avoiding any unreasonable electricity usage.

Lastly, a recent technology development for streetlights includes solar LED streetlights. This is a very efficient and more sustainable option that consists of a small solar PV system connected to and big enough to charge a battery that will power the LED light of the streetlamp for several hours when the sun goes down. This system, coupled with photocells that enable optimal operational hours of streetlights, allows energy savings because of the solar energy stored in a battery.

Please see Appendix 5 - Solar LED Street Lighting options for Great Missenden Street Lighting.

2.4 Community Heating

Community Heating opportunities beyond the building boundaries to explore the deployment of a Smart Local Energy System for the community.

A Smart Local Energy System (SLES) brings together different energy assets and infrastructure in a local area. Because these assets work together in a smarter way, a SLES increases value for the community and supports the local area to meet its carbon targets quicker and more cost effectively.

Some unused land owned by GMPC could be suitable for various technologies including solar PVs, battery storage, EV charging and ground source and air source heat pumps, which have lower environmental impact compared to traditional energy projects such as combined heat and power (CHP) plants.

The heat pumps could be connected to an energy centre that manages the heat produced and distributes it locally to residents and businesses as well as the electricity generated by solar PVs and stored in batteries.

Using a SLES to manage and optimise all these assets could reduce the carbon emissions in the local community. This type of solution however requires detailed feasibility studies, planning permissions and would require bespoke commercial agreements to materialise between different parties including the landowner, the end users, the Parish Council, the Local Authority, and the developer of the infrastructure and technology solution providers.

Section 3: Biodiversity Best Practice

All the plots of land owned or on lease to GMPC can be declared Local Nature Reserves (LNR)[1]. This declaration is made to Natural England and details how long the site will remain a protected LNR, ownership of the land, any agreements or partnerships, why the LNR site was chosen, aims and objectives, biodiversity management and environmental education, community participation, access and visitor management and costs and funding arrangements.

Declaring a LNR means you can create LNR bye laws to protect wildlife within the LNR. A nature reserve is an area of land managed to protect and maintain ecosystems. The sole purpose of a nature reserve is the protection of nature; however, nature reserves can also do a lot of good for people without jeopardising their goal. Nature reserves enhance the ability of the natural environment to provide for people's needs. A lot can be done for biodiversity without declaring a LNR. Protecting existing native plant species and detecting and preventing the spread of any invasive non-native species[2] along with establishing new growth of native plants maintains (with the potential for an increase in) biodiversity. In practice biodiversity is the variety of habitats, the variety of species and genetic variation within species.

Planting native trees and shrubs is an excellent way to support biodiversity. Flowering trees can be particularly important for pollinators in springtime because many types bloom early, when little else is in flower to provide food. Those with berries or seeds will also provide food for birds and mammals in the autumn. Good trees and shrubs to plant include Hawthorn, Hazel, Holly, Sessile Oak, Rowan, Spindle, Sweet Chestnut and Eared Willow[3].

Grasses are aggressive and will outcompete wildflowers in the fertile soil that covers the GMPC areas[4]. Where possible, for example at the edges of playing fields or the areas in Lovell Estate that are not used, should be left unfertilised to increase the growth of wildflowers. Wildflowers provide food for pollinators and other insects; birds and mammals will feed both on the fruits and seeds of the wildflowers as well as on the insects they support. From mid-March until mid-May dandelions are vital for bees and other early flying insects like butterflies. After the plant has finished flowering it produces seed that is fed on by birds such as the Greenfinch and Goldfinch. The leaves of the plant are also food for several moth larvae, including the Garden Tiger moth which has been in decline over the past few years. Cutting grass less frequently allows wildflowers to grow.

Wildflowers are essential for pollinators and can be encouraged in areas where mowing does not begin until after the 15th of April and then cut on a 6-weekly rotation. Not cutting until mid-April allows Dandelions to flower but not set seed. Cutting at the end of May and not again until mid-late July will increase the growth of important wildflowers like Clover, Selfheal, Cuckooflower and Bird's-foot-trefoil.

Retaining hedgerows provides vital corridors for biodiversity across the countryside. Most of the GMPC sites are surrounded by hedgerows which provide both food and nesting areas for insects, birds and mammals. Flowering hedgerows that contain Willow, Blackthorn and Hawthorn provide food for bees in spring and for birds and mammals in the autumn. Hedgerows should only be cut every three years to encourage flowering. The bases of hedgerows should not be sprayed to allow wildflowers to grow and provide areas for insects to nest.

Fig.1. Biodiversity best practice

Principle	In practice
Apply the mitigation hierarchy	Do everything possible to first avoid and then minimise impacts on biodiversity. Only as a last resort, and in agreement with external decision makers where possible, compensate for losses that cannot be avoided. If compensating for losses within the development footprint is not possible or does not generate the most benefits for nature conservation, then offset biodiversity losses by gains elsewhere.
Avoid losing biodiversity that cannot be offset elsewhere	Avoid impacts on irreplaceable biodiversity – these impacts cannot be offset to achieve NNL/net gain.
Be inclusive and equitable	Engage stakeholders early, and involve them in designing, implementing, monitoring and evaluating the approach to net gain. Achieve net gain in partnership with stakeholders where possible.
Address risk	Mitigate difficulty, uncertainty and other risks to achieving net gain. Apply well-accepted ways to add contingency when calculating biodiversity losses and gains in order to account for any remaining risks, as well as to compensate for the time between the losses occurring and the gains being fully realised.
Make a measurable net gain contribution	Achieve a measurable, overall gain for biodiversity and the services ecosystems provide while directly contributing towards nature conservation priorities.
Achieve the best outcomes for biodiversity	Achieve the best outcomes for biodiversity by using robust credible evidence and local knowledge to make clearly justified choices when: ▪ delivering compensation that is ecologically equivalent in type, amount and condition and that accounts for the location and timing of biodiversity losses ▪ compensating for losses of one type of biodiversity by providing a different type that delivers greater benefits for nature conservation ▪ achieving net gain locally to the development while also contributing towards nature conservation priorities at local, regional and national levels ▪ enhancing existing or creating new habitat ▪ enhancing ecological connectivity by creating more, bigger, better and joined areas for biodiversity.
Be additional	Achieve nature conservation outcomes that demonstrably exceed existing obligations, ie do not deliver something that would occur anyway.
	Ensure net gain generates long-term benefits by: ▪ engaging stakeholders and jointly agreeing practical solutions that secure Net Gain in perpetuity
Create a net gain legacy	Ensure net gain generates long-term benefits by: ▪ engaging stakeholders and jointly agreeing practical solutions that secure Net Gain in perpetuity ▪ planning for adaptive management and securing dedicated funding for long-term management ▪ designing net gain for biodiversity to be resilient to external factors, especially climate change ▪ mitigating risks from other land uses ▪ avoiding displacing harmful activities from one location to another ▪ supporting local-level management of net gain activities.
Optimise sustainability	Prioritise BNG and, where possible, optimise the wider environmental benefits for a sustainable society and economy.
Be transparent	Communicate all net gain activities in a transparent and timely manner, sharing the learning with all stakeholders.

Legend

- Pedestrian access
- Vehicle access

Fig.2. Ballinger Allotments

Fig.4. Greenlands Lane

Fig.3. Chequers Lane

Fig.5. Potter Row

Fig.6. Nairdwood Lane Allotments

Fig.7. Spurlands End Road

Ensuring an allotment is rich in species diversity can increase its productivity as it will have fewer pests and diseases. An approach to managing allotments while maintaining biodiversity includes using alternatives to pesticides[5]. These are all strategies that can be implemented in the GMPC owned allotments:

- Using pesticides only in the area of need rather than the whole area
- Planting native species that naturally outcompete weeds
- Laying mulch on areas of unwanted weed growth
- Reducing the frequency of pesticide use when not proven necessary
- Mechanical methods such as physically removing unwanted growth
- Mowing or strimming weeded areas instead of applying pesticides
- Thermal control with hot water or foam
- Wire brushes spun at speed over hard surfaces pulling weeds out and discouraging future growth.
- Hedgehog boxes provide shelter for an important local species that eat pests like slugs
- Bird feeders reduce the need for birds to feed on allotment crops in the winter

Companion planting means plants can attract pollinators to, and deter pests from, their companions, tall plants can provide shade for smaller plants that need it, and plants can balance the nutrient supply from the soil.

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Fig.8.

Garden crop	Companion plants
Beans	Broccoli, Cabbage, Carrots, Cauliflower, Corn, Cucumbers, Aubergine, Garden peas, Potatoes, Radishes, Squash, Strawberries, Tomatoes
Carrots	Beans, Garden peas, Lettuce, Onions, Tomatoes
Cabbage and other cole crops (broccoli, Brussels sprouts, collard greens, kale, kohlrabi, rutabagas, turnips)	Other cole crops, Onions, Potatoes
Corn	Beans, Cucumbers, Garden peas, Melons, Potatoes, Squash
Cucumbers	Beans, Beets, Corn, Onions, Garden peas, Radishes
Garden peas	Beans, Carrots, Corn, Cucumbers, Aubergine, Peppers, Radishes, Spinach, Tomatoes
Garlic	Beets, Carrots, Cole crops, Aubergine, Peppers, Potatoes, Tomatoes
Lettuce	Corn, Pumpkins, Radishes, Squash
Melon and watermelon	Broccoli, Corn, Garlic, Radishes
Onions	Beets, Carrots, Cole crops, Lettuce
Peppers	Basil, Onions, Okra
Potatoes	Beans, Cole crops, Corn, Lettuce, Spinach, Radishes
Summer squash/courgette	Beans, Corn, Garden peas, Radishes
Tomatoes	Basil and other herbs, Carrots Cucumbers Squash as part of a three-way companion partnership

WHO recommended classification of pesticides by hazard and guidelines to classification lists *Technical grade active ingredients of pesticides unlikely to present acute hazard in normal use* here[6] on pages 49-58. The Health and Safety Executive (HSE) is the national regulator for pesticides and hosts the pesticide approval register of all accepted pesticides for use in the UK here[7].

Fig.9. Safer pesticides for use when alternatives are not possible

Target Pest	Product Type	Active Ingredient(s)
Aphids, scales, mites, leafhoppers, hemlock woolly adelgid, mealybugs and powdery mildew	Horticultural oil (dormant oil for winter season, summer oils for growing season)	Highly refined paraffinic oil or petroleum oil
Aphids, ants, scales, mites, mealybugs, small caterpillars, and other soft-bodied insects, weeds	Insecticidal soap	Potassium salts of fatty acids
Aphids, whiteflies, mites, extract of black spot, powdery mildew, rust, anthracnose, grubs and	Neem Oil	Clarified hydrophobic neem oil
Ants	1.Arsenic ant baits 2.Sulfluramid ant baits	1.Arsenic trioxide 2.N-ethyl perflourooctanesulfonamide
Ants & Cockroaches	1.Abamectin ant & roach baits 2.Borax 3.Fipronil ant and roach baits 4.Hydramethylnon baits	1.Abamectin 2.Sodium tetrahydrate decahydrate 3.Fipronil 4.Hydramethylnon
Ants, Cockroaches & Fleas	1.Citrus oil spray 2.Diatomaceous earth, Desicating dust, Insecticidal dust	1.d-Limonene 2.Silicon dioxide
Ants, cockroaches, fleas, silverfish, termites	Boric acid/ borate products	Orthoboric acid
Mosquitos, aphids, ants, leafhoppers, thrips, whiteflies	Garlic (Concentrated garlic 'clips' to attach to plants OR Garlic oil sprays)	Garlic
Snails & slugs	1.Snail & slug bait 2.Snail & slug barrier 3.Diatomaceous earth	1.Iron phosphate 2.Coconut oil soap 3.Silicon dioxide
Weeds	1.Herbicidal (insecticidal) soap 2.Corn gluten meal 3.Vinegar spray 4. Pelargonic acid herbicide	1.Potassium salts of fatty acids 2.Corn gluten 3. 20% Vinegar, put in spray bottle 4.Pelargonic acid
White grubs	Imidacloprid	Imidacloprid
Yellow jackets and other flying insects	Mint oil	Mint oil, sodium lauryl sulfate

Fig.10. Sibley's Rise

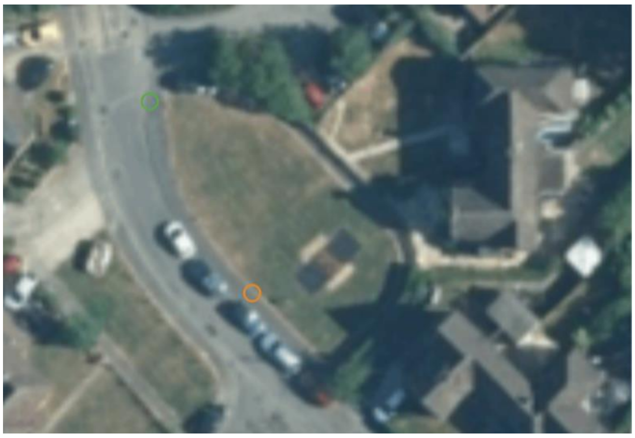

Fig.11. Pictured is the largest plot from the Lovell Estate

Fig.12. Ballinger Common

Sibley's Rise (Fig. 10) is a small parcel of land owned by the Paradigm Housing Association with children's play equipment on it. GMPC owns various small parcels of land on the Lovell Estate. These plots are suitable for a planting regime where 'weeds' that are native species which grow successfully in the area already are allowed to establish and produce displays of flowers and foliage that pollinators feed on and can compete aesthetically with other ornamental plant varieties.

Fig.13. Buryfield

Fig.14. Frith Hill

Fig.15. Nairdwood Lane Common

Fig.16. London Road

These plots would be suitable to be converted into carbon sinks as they have plenty of space for tree planting while leaving room for recreation. This provides an opportunity to offset the GMPC carbon footprint.

The best trees to plant are trees that are already successful on or near the site like oaks. Trees that can grow on these sites that are successful carbon sequesters include Elder, Field Maple, Hawthorn, Holly and Yew which are medium sized and Hazel, Blackthorn, Crab Apple and Goat Willow which are smaller sized.

APPENDIX 1 - Tables of calculated CO_2 Emissions by category

Table 2 - CO2 emissions gas Memorial Centre

Invoice Period	Total Consumption (kWh)	Unit Charge (p/kWh)	BEIS conversion Factor	Calculated CO2 Emissions in tonnes (tCO2)
15 December 2020 to 11 January 2021	11,349.58	4.437	0.20258	2.30
12 January 2021 to 15 February 2021	13,450.19	4.437	0.20258	2.72
16 February 2021 to 16 March 2021	7,216.52	4.437	0.20258	1.46
16 March 2021 to 31 March 2021	3,041.19	4.437	0.20258	0.62
01 April 2021 to 08 April 2021	1,755.73	4.437	0.20258	0.36
08 April 2021 to 09 April 2021	0.00	4.437	0.20258	0.00
08 April 2021 to 17 May 2021	5,706.14	4.437	0.20258	1.16
18 May 2021 to 09 June 2021	2,357.46	4.437	0.20258	0.48
10 June 2021 to 21 July 2021	31.19	4.437	0.20258	0.01
22 July 2021 to 18 August 2021	1,724.38	4.437	0.20258	0.35
19 August 2021 to 09 September 2021	1,071.44	4.437	0.20258	0.22
10 September 2021 to 14 October 2021	3,412.10	4.437	0.20258	0.69
15 October 2021 to 4 November 2021	4,486.29	4.437	0.20258	0.91
05 November 2021 to 09 December 2021	10,809.03	4.437	0.20258	2.19
10 December 2021 to 13 January 2022	11,001.49	4.437	0.20258	2.23
14 January 2022 to 01 February 2022	7,292.41	4.437	0.20258	1.48
02 February 2022 to 09 March 2022	10,746.00	4.437	0.20258	2.18
09 March 2022 to 31 March 2022	5,451.79	4.437	0.20258	1.10
01 April 2022 to 01 April 2022	283.61	4.437	0.20258	0.06
01 April 2022 to 28 April 2022	3,601.67	4.437	0.20258	0.73
29 April 2022 to 21 May 2022	2,211.55	11.693	0.20258	0.45
Total	**106,999.76**			**21.68**

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Table 3 - CO2 emissions electricity Memorial Hall

Invoice Period	Total Consumption (kWh)	Unit Charge (p/kWh)	BEIS conversion Factor (elec generation)	BEIS conversion Factor (Transmission & Distribution)	Total BEIS conversion Factors	Calculated CO2 Emissions (tCO2)
19 March 2021 to 19 April 2021	291.00	12.51	0.21016	0.0186	0.22876	0.07
19 April 2021 to 18 May 2021	213.00	12.51	0.21016	0.0186	0.22876	0.05
19 May 2021 to 18 June 2021	323.00	12.51	0.21016	0.0186	0.22876	0.07
19 May 2021 to 18 June 2021	574.00	16.98	0.21016	0.0186	0.22876	0.13
19 June 2021 to 18 July 2021	314.20	16.982	0.21016	0.0186	0.22876	0.07
19 July 2021 to 18 August 2021	181.10	16.982	0.21016	0.0186	0.22876	0.04
19 August 2021 to 18 September 2021	357.90	18.825	0.21016	0.0186	0.22876	0.08
19 September 2021 to 18 October 2021	385.70	18.825	0.21016	0.0186	0.22876	0.09
19 October 2021 to 18 November 2021	264.30	18.825	0.21016	0.0186	0.22876	0.06
19 October 2021 to 18 November 2021	166.60	30.064	0.21016	0.0186	0.22876	0.04
19 November 2021 to 18 December 2021	475.40	30.064	0.21016	0.0186	0.22876	0.11
19 December 2021 to 18 January 2022	446.00	30.064	0.21016	0.0186	0.22876	0.10
19 January 2022 to 18 February 2022	533.50	30.064	0.21016	0.0186	0.22876	0.12
19 February 2022 to 18 March 2022	415.60	30.064	0.21016	0.0186	0.22876	0.10
19 March 2022 to 18 April 2022	471.20	30.064	0.21016	0.0186	0.22876	0.11
19 April 2022 to 18 May 2022	341.10	30.064	0.21016	0.0186	0.22876	0.08
Total	**5,753.60**					**1.32**

Table 4 - CO_2 emissions electricity Parish Office

Invoice Period	Total Consumption (kWh)	Unit Charge (p/kWh)	BEIS conversion Factor (elec generation)	BEIS conversion Factor (Transmission & Distribution)	Total BEIS conversion Factors	Calculated CO_2 Emissions (tCO_2)
31 December 2020 to 31 January 2021	159.00	21.36	0.21016	0.0186	0.22876	0.036
01 February 2021 to 22 February 2021	66.00	21.36	0.21016	0.0186	0.22876	0.015
22 February 2021 to 01 April 2021	150.00	21.36	0.21016	0.0186	0.22876	0.034
02 May 2021 to 25 May 2021	92.00	21.36	0.21016	0.0186	0.22876	0.021
25 May 2021 to 24 June 2021	105.00	21.36	0.21016	0.0186	0.22876	0.024
24 Jun 2021 to 21 Jul 2021	98.00	21.36	0.21016	0.0186	0.22876	0.022
21 July 2021 to 18 August 2021	120.00	21.36	0.21016	0.0186	0.22876	0.027
19 August 2021 to 31 August 2021 (day)	37.00	21.36	0.21016	0.0186	0.22876	0.008
19 August 2021 to 31 August 2021 (night)	5.70	21.36	0.21016	0.0186	0.22876	0.001
01 September 2021 to 30 September 2021 (day)	87.70	21.36	0.21016	0.0186	0.22876	0.020
01 September 2021 to 30 September 2021 (night)	14.10	21.36	0.21016	0.0186	0.22876	0.003
01 October 2021 to 03 November 2021 (day)	167.30	21.36	0.21016	0.0186	0.22876	0.038
01 October 2021 to 03 November 2021 (night)	30.30	21.36	0.21016	0.0186	0.22876	0.007
04 November 2021 to 24 November 2021 (day)	83.90	21.36	0.21016	0.0186	0.22876	0.019
04 November 2021 to 24 November 2021 (night)	16.40	21.36	0.21016	0.0186	0.22876	0.004
24 November 2021 to 01 December 2021 (day)	33.90	23.60	0.21016	0.0186	0.22876	0.008
04 November 2021 to 01 December 2021 (night)	6.60	23.60	0.21016	0.0186	0.22876	0.002
01 December 2021 to 31	131.70	23.60	0.21016	0.0186	0.22876	0.030

December 2021 (day)						
01 December 2021 to 31 December 2021 (night)	25.90	23.60	0.21016	0.0186	0.22876	0.006
01 January 2022 to 31 January 2022 (day)	62.40	23.60	0.21016	0.0186	0.22876	0.014
01 January 2022 to 31 January 2022 (day)	9.10	23.60	0.21016	0.0186	0.22876	0.002
01 February 2022 to 28 February 2022 (day)	92.00	23.60	0.21016	0.0186	0.22876	0.021
01 February 2022 to 28 February 2022 (night)	17.00	23.60	0.21016	0.0186	0.22876	0.004
01 March 2022 to 31 March 2022 (day)	88.00	23.60	0.21016	0.0186	0.22876	0.020
01 March 2022 to 31 March 2022 (night)	21.00	23.60	0.21016	0.0186	0.22876	0.005
01 April 2022 to 30 April 2022 (day)	73.00	23.60	0.21016	0.0186	0.22876	0.017
01 April 2022 to 30 April 2022 (night)	19.00	23.60	0.21016	0.0186	0.22876	0.004
Total	**1,812.00**					**0.415**

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Table 5 - CO2 emissions electricity Prestwood Community Centre

Invoice Period	Total Consumption (kWh)	Unit Charge (p/kWh)	BEIS conversion Factor (elec generation)	BEIS conversion Factor (Transmission & Distribution)	Total BEIS conversion Factors	Calculated CO2 Emissions (tCO2)
18 Dec 2020 to 11 Jan 2021	2,430.00	14.20	0.21016	0.0186	0.22876	0.56
11 Jan 2021 to 16 Feb 2021	3,436.00	14.20	0.21016	0.0186	0.22876	0.79
16 February 2021 to 11 March 2021	1,236.00	14.20	0.21016	0.0186	0.22876	0.28
11 March 2021 to 03 April 2021	809.00	14.20	0.21016	0.0186	0.22876	0.19
03 April 2021 to 10 May 2021	1,302.00	15.70	0.21016	0.0186	0.22876	0.30
10 May 2021 to 18 June 2021	731.00	15.70	0.21016	0.0186	0.22876	0.17
18 June 2021 to 14 July 2021	275.00	15.70	0.21016	0.0186	0.22876	0.06
14 July 2021 to 11 August 2021	108.00	15.70	0.21016	0.0186	0.22876	0.02
12 August 2021 to 30 September 2021	1,579.30	15.70	0.21016	0.0186	0.22876	0.36
01 October 2021 to 07 November 2021	992.70	15.70	0.21016	0.0186	0.22876	0.23
08 November 2021 to 30 November 2021	968.20	15.70	0.21016	0.0186	0.22876	0.22
01 December 2021 to 31 December 2021	1,321.70	15.70	0.21016	0.0186	0.22876	0.30
01 January 2022 to 02 February 2022	5,207.10	15.70	0.21016	0.0186	0.22876	1.19
03 February 2022 to 28 February 2022	2,011.00	15.70	0.21016	0.0186	0.22876	0.46
01 March 2022 to 31 March 2022	2,625.00	15.70	0.21016	0.0186	0.22876	0.60
01 April 2022 to 03 April 2022	87.20	15.70	0.21016	0.0186	0.22876	0.02
03 April 2022 to 26 April 2022	912.80	26.20	0.21016	0.0186	0.22876	0.21
Total	**26,032.00**					**5.96**

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Table 6 - CO2 emissions street lighting

Invoice Period	Total Consumption (kWh)	Unit Charge (p/kWh)	BEIS conversion Factor (elec generation)	BEIS conversion Factor (Transmission & Distribution)	Total BEIS conversion Factors	Calculated CO2 Emissions (tCO2)
01 March 2021 to 31 March 2021	2,162.40	14.939	0.21016	0.0186	0.22876	0.49
01 April 2021 to 30 April 2021	2,092.64	14.939	0.21016	0.0186	0.22876	0.48
01 May 2021 to 31 May 2021	2,162.40	14.939	0.21016	0.0186	0.22876	0.49
01 June 2021 to 30 June 2021	2,092.64	17.596	0.21016	0.0186	0.22876	0.48
01 July 2021 to 31 July 2021	2,162.40	17.596	0.21016	0.0186	0.22876	0.49
01 August 2021 to 31 August 2021	2,162.40	17.596	0.21016	0.0186	0.22876	0.49
01 September 2021 to 30 September 2021	2,092.64	17.596	0.21016	0.0186	0.22876	0.48
01 October 2021 to 31 October 2021	2,162.40	17.596	0.21016	0.0186	0.22876	0.49
01 November 2021 to 30 November 2021	2,092.64	17.596	0.21016	0.0186	0.22876	0.48
01 December 2021 to 31 December 2021	2,646.50	17.596	0.21016	0.0186	0.22876	0.61
Total	**21,829.06**					**4.99**

APPENDIX 2 – Modelling Assumptions

A. Memorial Centre and Parish Office

We are modelling April 21st 2021 to 19th April 2022

- We have monthly electricity and gas meter readings and invoices for 2021/22. These monthly consumption values have been distributed at a half hour level according to the events scheduled in the booking calendar.
- Allow a 30m buffer before each event for prep time and 30m after each event e.g., for events running over/everyone getting ready and leaving the room.
- We only have booking data from 4th Apr 2021 to 21st Dec 2021. So, we need to estimate booking data from 21st Dec 2021 to 19th Apr 2022. The last booking in dec is on 21st due to Christmas holidays, so estimate Jan - Apr 22
- Assume the cold winter months of Jan & Feb 22 follow the same booking schedule as November 21
- Assume the spring months of March & April 22 follow the same booking schedule as May 21
- Only standard/normal unit charge p/kwh used for cost calculations, not standing charge or climate change levy
- Only used actual customer meter readings (not estimates) and assumed meters were read at 12:00:00 midday.
- In addition, the monthly electricity consumption values for the parish office were distributed according to the Ofgem half-hourly electricity demand profile for commercial offices. Assumed the parish office was closed on the weekend.
- Monthly Gas consumption distributed at a half hour level by matching the distribution of total half-hourly electricity consumption.
- Estimated electricity cost savings based on a weighted average of memorial centre and parish office unit costs
- Assume the installation of a heat pump will reduce gas consumption by 90%. 10% of current gas consumption will still be used for DHW and cooking.

Electric Vehicle Charging

- 1 x 7KW dual charger which can supply 2 parking spaces
- Assume it constantly supplies electricity to 2 EVs simultaneously when there is an event in the booking schedule
- So, power = 2 x 7kW = 14KW so 14/2 = 7 kWh per half hour

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B. Prestwood Community Centre - Prestwood Youth & Community Action Group

We are modelling 10 May 2021 to 26 April 2022

We want to estimate half-hourly electricity readings for 2021/22

Given the power rating (kW) of heating systems, lighting and other electrical appliances in the building and by making assumptions on time of operation of these appliances based on typical usage, seasonality and the events scheduled in bookings calendar, distribute the monthly electricity consumption values and bills at the half-hourly level.

1. We have monthly electricity meter readings and invoices for 2021/22
2. We have their booking calendar of scheduled events for 2021 and 2022 (excel)

Assumptions

- Allow a 30m buffer before each event for prep time and 30m after each event e.g., for events running over/everyone getting ready and leaving the room.
- Average temperature of London (Great Missenden) for the last 10 years for each 30m time interval was used to estimate COP
- Only standard/normal unit charge p/kwh used for cost calculations, not standing charge or climate change levy
- Only used actual customer meter readings (not estimates) and assumed meters were read at 12:00:00 midday.

Electrified heating system

- Only turned-on during events according to booking schedule

Space heating

- 5 x 2kW electric heaters in the main hall
- 3 x 500w small electric heaters in the bathrooms
- All heaters constantly turned on in winter, 50% power constantly turned on in autumn and spring, turned off completely in summer

Domestic Hot Water

- 3 x 2kW electric boilers/water heaters
- On average 10 half-hour slots booked each day = 5 hours of events per day. Roughly 3 or 4 events each 1-2 hrs in duration each day on avg. Assume 4 events with 15 people on average attending. Each person turns on the hot tap water for 20s. So, the total duration is 20m. But it takes 40s to heat the water so 1m each use. Hence total is 1hr. So assumed that 20% of

the time the boilers turned on using full power. Same as assuming 20% of power is constantly turned on.

Lighting

- Only turned-on during events according to booking schedule

Indoor lighting

- 8 neon lamps (x2 tubes) in main hall, 1 neon lamp (1 tube) in entrance hall, 3 rooms with 1 neon lamp (1 tube) so total = 12
- Each neon tube lamp has a power of 58W (see photos)
- Assumed 10 lights will constantly be turned on when there is an activity/event (8 for main hall, 1 for entrance to hall & 1 room)
- Hence total power = 58x10 = 580 W
- So, 580/2 = 0.29 kWh per half hour

Outdoor lighting

- Assumed all lighting automatically turns on at dusk/sunset when sunlight starts to fade and stays on until dawn/sunrise when as sun starts to shine
- Turns off 30m after last event for the day
- Flood lights - only autumn, spring & winter in the evenings. Turned off in summer.
- 2 x Sodium (80W) + 1 x LED 18W

Electric Vehicle Charging

- 1 x 7KW dual charger which can supply 2 parking spaces
- Assume it constantly supplies electricity to 2 EVs simultaneously when there is an event in the booking schedule
- So, power = 2 x 7kW = 14KW so 14/2 = 7 kWh per half hour

<u>Other appliances</u>

Fridge

- - Power of 200W and turned on constantly 24/7 regardless of events

Kettle

- Power is 2kW
- 2 cups take 2m to boil
- 60 people each day, a third have a tea/coffee, so 20 cups each day
- used for 20m per day

- used for 5 * 60 = 300/20 = 1/15th of the time
- so assumed constantly uses 1/15 power during events
- equals 2 * 1/15 = 0.13 KW = 0.06kwh energy per half hour

Exclusions:

- Only standard/normal unit charge p/kwh used for cost calculations, standing charge or climate change levy not included at this stage

APPENDIX 3 – Prestwood Community centre LED lighting replacement assumptions and calculations

Indoor lighting

- Current lighting: fluorescent tube light 58W (ref. pictures taken)
- Proposed new LED lights 22W (ref. https://ledhut.co.uk/blogs/news/led-equivalent-wattages-against-traditional-lighting)
- Total annual consumption LED lights replacement: 126.17 kWh
- Total annual kgCO2 emissions LED lights replacement: 28.86
- Potential annual carbon savings after LED lights replacement: 64.09 kgCO2 (68.95%)

Table 1 - Annual kgCO2 calculated for current indoor lighting

Total annual consumption current lights (kWh)	BEIS conversion factor	Annual kgCO2
406.313	0.22876	92.95

Table 2 - Annual kgCO2 calculated for LED indoor lights replacement

Total annual consumption LED lights (kWh)	BEIS conversion factor	Annual kgCO2
126.17	0.22876	28.86

Outdoor lighting

- Current lighting: 2 sodium lights (assumed 80W each), 1 LED light (assumed 18W)
- Proposed new LED lights 18W each
- Total annual consumption LED lights replacement: 28.57 kWh
- Total annual kgCO2 emissions LED lights replacement: 6.53
- Potential annual carbon savings after LED lights replacement: 20.37 kgCO2 (75.72%)

Table 3 - Annual kgCO2 calculated for current outdoor lights

Total annual consumption current lights (kWh)	BEIS conversion factor	Annual kgCO2
117.59	0.22876	26.90

Table 4 - Annual kgCO2 calculated for LED outdoor lights replacement

Total annual consumption LED lights (kWh)	BEIS conversion factor	Annual kgCO2
28.57	0.22876	6.53

Total Carbon Reduction (Indoor & Outdoor lighting) = 90.99 kgCO2 or 1.4% of total annual carbon emissions.

APPENDIX 4 – Air Heat Emitters options for Air Source Heat Pumps (Prestwood Community & Youth centre)

Fan Assisted radiators:

- Distribute heat by means of convection
- Smaller than standard wet radiators, stable for low temperatures
- Have copper aluminium heat exchangers, small fans and low water content
- Can provide up to 3 times more heat output than a conventional radiator
- Require electrical connection and consume a small portion of electricity

Source: https://www.kensaheatpumps.com/wp-content/uploads/2014/09/Factsheet-Fan-Assisted-Radiators-V2.pdf

Product examples:

- Manufacturer: Dimplex. Model: White Glass SmartRad SRX080EWG. Price £515.83. Source: https://www.dimplex.co.uk/product/white-glass-smartrad-srx080ewg
- Manufacturer: Mitsubishi Electric. Model: iLife2 Slim. Climaveneta Ecodan i-Life2 Slim Radiator 80 DLMV. Price: £570.49 (inc. TAX).
  Reseller Source: https://www.swatengineering.co.uk/shop/climaveneta-ecodan-i-life2-slim-radiator-80-dlmv

Heat pump Convectors:

- Distribute heat by means of convection and works in the same way a radiator does
- Can be installed in walls and ceilings
- The unit can modulate its air flow to meet changes in heating demand
- Require electrical connection and consume a small portion of electricity

Source: https://www.daikin.co.uk/en_gb/product-group/daikin-altherma-hpc.html

Product example

Manufacturer: Dimplex. Model: Daikin Altherma HPC. Price: £496.80 (inc. VAT). Reseller Source: https://heatpumpsupplies.shop/products/heat-pump-convectors-hpc-fwxv-atv3

Split System Heat Pumps

- Use an outdoor unit and an indoor unit connected through copper piping
- versatile and customisable
- Air source heat pump manufacturers have their proprietary split systems

Source: https://www.heatpumpsource.co.uk/blog/split-system-heat-pumps-guide/

Product examples

- Manufacturer: Mitsubishi Electric. Category: Multi-Split systems. Source: https://les.mitsubishielectric.co.uk/products/air-conditioning/multi-splits
- Manufacturer: Daikin. Category: Multi-Split. Source: https://www.daikin.co.uk/en_gb/product-group/air-to-air-heat-pumps/multi.html
- Manufacturer: Vaillant. Product range: aroTHERM Split air source heat pump. Source: https://www.vaillant.co.uk/homeowners/products/the-arotherm-split-air-source-heat-pump-62272.html

APPENDIX 5 - Solar LED Street Lighting options for Great Missenden Street Lighting

Manufacturer: Proelectric. Product range examples:

- AE3 Solar LED Street and Car Park Lighting.
    - Permanent streetlight year-round suitable for multiple application, including: street lighting, car parks, bus stops and shelters
    - Doesn't need external electrical power
    - Models available with 55W or 80W solar panels
    - LED light 5W or 10 W. The LED lifetime is 60,000 hrs
    - Battery size: 615Wh

  Source: https://www.prolectric.co.uk/lighting/solar-street-lights/ae3-solar-led-street-lights/

- AE6 Solar LED Street Lights.
    - Permanent streetlight year-round suitable for multiple application, including: street lighting, car parks, bus stops and shelters
    - Doesn't need external electrical power
    - LED light 10W or 20 W.
    - Battery chemistry: lithium LiFePO4

  Source: https://www.prolectric.co.uk/lighting/solar-street-lights/ae6-solar-led-street-lights/

Manufacturer: Dragons Breath Solar. Product range examples:

- DBS1204 bespoke multi-directional solar powered lighting system.
    - suitable for car parks and walkways, farms, bridal paths, allotments
    - designed for locations where power is not readily available and to perform in all UK weather and climate conditions
    - LED light 12W
    - Battery chemistry: lithium LiFePO4 or AGM (lead-acid battery)
    - Price from £1,466.99 (inc. VAT)

    Source: https://www.dragonsbreathsolar.co.uk/product/dragons-breath-street-lights/

- DBS bespoke retro multi-directional solar lighting system.
    - designed to be retro fixed in new or existing lamp posts
    - designed for locations where power is not readily available and to withstand extreme weather conditions
    - solar panel size: 150W or 150W
    - battery chemistry: li-ion (LiFePo4) battery pack. Can provide 2-3 days built in autonomy
    - equipped with photocell technology
    - Price from £1,408.80 (inc. VAT)

    Source: https://www.dragonsbreathsolar.co.uk/product/multi-directional-solar-lighting/

Manufacturer: UK Solar Power. Product range examples:

- V9A and V9C SERIES
    - suitable for car parks, main roads and avenues, gardens
    - designed for locations where power is not readily available
    - LED light: Philips LED (Superior LED technology)
    - Battery chemistry: lithium LiFePO4
    - IP68 waterproof
    - V9C series have CCTV and 4G technology built in

  Source:
  https://www.uksolarpower.com/_files/ugd/5c11e0_d0f031be51624706b6deb9c0527d6b21.pdf

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APPENDIX 6 - Biodiversity Best Practice References

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