Bentley House

Energy Strategy

for

The Wellcome Trust

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1. Executive Summary

This document responds to planning policy in respect of energy consumption and carbon dioxide emissions. The methodology used is compiled in response to current planning policy, in particular, to the Mayor's London Plan and Camden's Unitary Development Plan.

The Proposed Development features the following energy-saving measures:

- Improved U-values beyond Part L compliance;
- All internal, external and communal lighting to be provided through low energy lighting, wherever possible;
- Improved air permeability beyond Part L compliance;
- Energy efficient mechanical and electrical plant.

Energy saving measures will be used to reduce the Proposed Development's carbon dioxide emissions and to exceed the compliance requirements of Part L2A of the Building Regulations.

The feasibility of a site wide district heating system has been explored. There is not a district heating system close to the site. However it is proposed that heating and domestic hot water shall be circulated by a single network which allows for connection to a district heating system, should a system be established. The heating and hot water shall be supplied by a Combined Heat and Power (CHP) engine connected to a low loss header from where heating water and domestic hot water can be supplied. The system will be backed by an energy efficient gas-fired boiler which supplies the heating demand peaks. This system can be metered on a single room basis or on a larger scale. It is anticipated that the electricity produced by the CHP will be used within the scheme via a distribution board, and any surplus electricity will be fed back into the grid – in which case it is expected that a feed-in tariff will be paid to the building owner.

Additionally, the proposed development has been assessed to determine the feasibility of numerous low and zero carbon technologies. The site, in its current format and design status, is not deemed to be an appropriate location for many truly renewable technologies.

The passive technologies and energy saving measures above lead to an annual emissions rate of 737 tCO_2. The addition of a CHP unit provides an annual reduction of 147 tCO_2 which equates to a reduction of 20 % of the total site carbon dioxide emissions. Also, there is limited scope for the addition of Solar Photovoltaics on site. It is tentatively suggested, pending a more detailed shading analysis, that 20m^2 of PV could be integrated at the North end of the roof of the development. This would produce CO_2 savings of 1.5 tonnes, or, approximately 0.2% of site emissions. The development is therefore compliant with the Mayor's London Plan and Camden's UDP.

The predicted energy consumption for the site are shown in Figure 1.

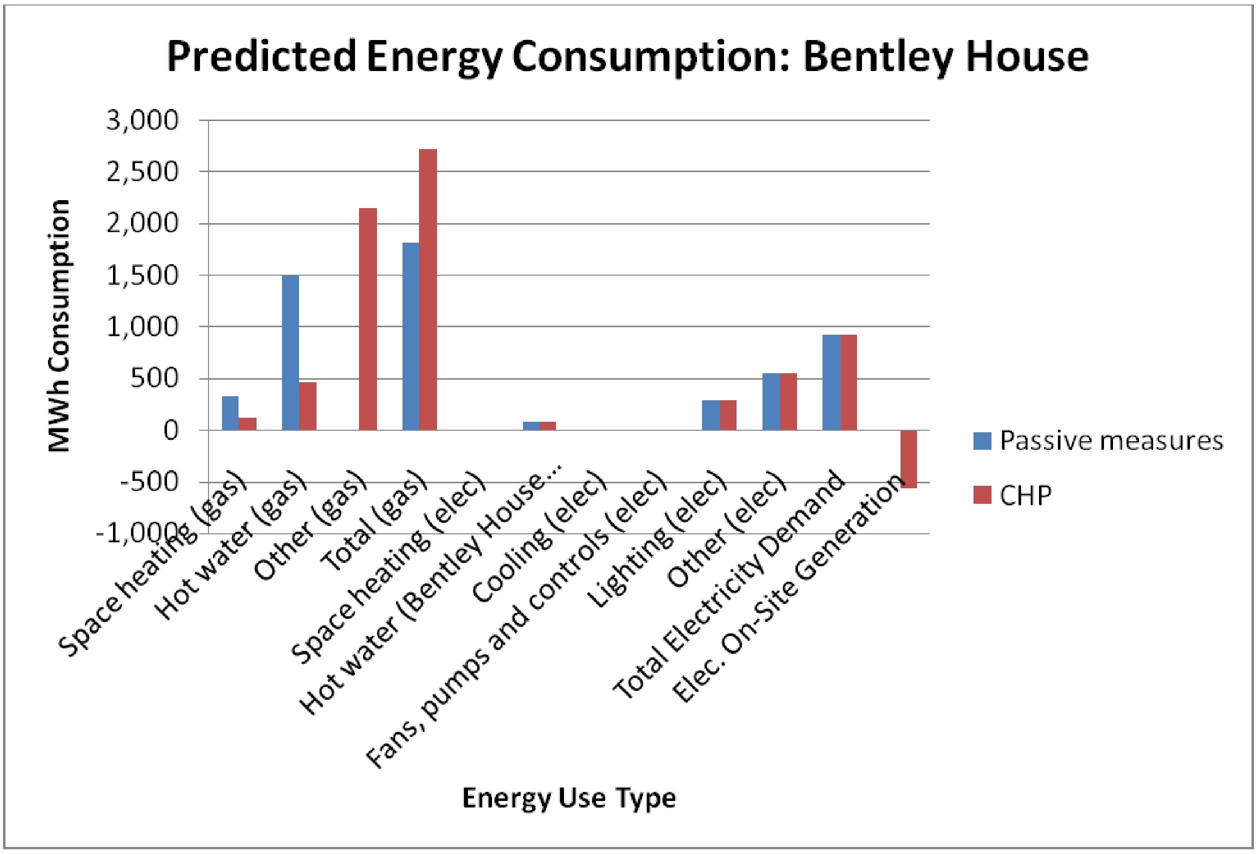

Figure 1

1.1 Ramboll UK has been appointed by The Wellcome Trust to provide an Energy Strategy as part of the planning submission documents for the scheme at the Bentley House site.

1.2 This Energy Strategy is for the exclusive use of the Client and should not be used in whole or in part by any third parties without the express permission of RUK in writing.

2. Planning Policy Context

National

The following description is taken from the LRT.

'Increased development of renewable energy resources is vital to facilitating the delivery of the Government's commitments on both climate change and renewable energy. The Governement's Energy Policy, including its policy on renewable energy, is set out in the energy White Paper. This aims to put the UK on a path to cut its carbon dioxide emissions by some 60 % by 2050, with real progress by 2020, and to maintain reliable and competitive energy supplies. As part of the strategy for achieving these reductions the White Paper sets out:

- The Government's target to generate 10 % of UK electricity from renewable energy sources by 2010.
- The Government's aspiration to double that figure to 20 % by 2020 and suggests that still more renewable energy will be needed beyond that date.'

'The Energy White Paper indicated that the Government would be looking to work with regional and local bodies to deliver its objectives, including establishing regional targets for renewable energy generation for its respective region, derived from assessments of the region's renewable energy resource potential.'

'*Planning Policy Statement 22 (PPS22)* sets out the Government's national policy for renewable energy, in terms of both dedicated renewable generation projects (e.g. wind farms) and 'embedded' generation. It states that 'local planning authorities may include policies in local development documents that require a percentage of the energy to be used in new residential, commercial or industrial developments to come from on-site renewable energy developments. Such policies:

- Should ensure that requirement to generate on-site renewable energy is only applied to developments where the installation of renewable energy generation equipment is viable given the type of development proposed, its location, and design;
- Should not be framed in such a way as to place an undue burden on developers, for example, by specifying that all energy to be used in a development should come from on-site renewable generation.'

Regional

In London the Mayor has established policies and strategies relating to renewable energy use in London.

"The Energy Strategy is one of a series dealing with environmental issues in London [and]…sets out the Mayor's proposal for change in the way energy is supplied and used within London over the next 10 years and beyond. The Strategy aims to improve London's environment, reduce the capital's contribution to climate change, tackle fuel poverty and promote economic development."

Policy 4A.7 Renewable Energy states ''The Mayor will, and boroughs should, in their DPDs adopt a presumption that the developments will achieve a reduction in carbon dioxide emissions of 20 % from on site renewables energy generation unless it can be demonstrated that such provision is not feasible. This will support the Mayor's Climate Change Mitigation and Energy Strategy and its objectives of increasing the proportion of energy used generated from renewable sources by:

- Requiring the inclusion of renewable energy technology and design, including; biomass fuelled heating, cooling and electricity generating plant, biomass heating, renewable energy from waste, photovoltaics, solar water heating, wind, hydrogen fuel cells and ground source heat pumps.

Section 4.8 of Chapter 4 in the *London Plan* covers 'Tackling climate change. The key policies in respect of the design of buildings are summarised below;

The Mayor will, and boroughs should, in their DPDs require developments to make the fullest contribution to the mitigation of the adaptation to climate change and to minimize emissions of carbon dioxide.

The following hierarchy will be used to assess applications:

- Using less energy, in particular by adopting sustainable design and construction measures (Policy 4A.3)

- Supplying energy efficiency, in particular by prioritizing decentralized energy generation (Policy 4A.6), and

- Using renewable energy (Policy 4A.7)

These contributions should most effectively reflect the context of each development – for example, its nature, size, location, accessibility and operation. The Mayor will and boroughs should ensure that development is located, designed and built for the climate that it will experience over its intended lifetime.

Local

The London Borough of Camden Replacement Unitary Development Plan (UDP) (Adopted June 2006) policy SD9C 'Use of energy and resources' states that:

The Council will seek developments that conserve energy and resources through:

a) designs for energy efficiency;

b) renewable energy use;

c) optimising energy supply; and

d) the use of recycled and renewable building materials.

The Council will require major developments to demonstrate the energy demand of their proposals and how they would generate a proportion of the site's electricity and heating needs from renewables wherever feasible. The Council may use conditions or planning obligations to secure recycling of materials on site and/or use of recycled aggregates in major schemes

Site Description

The proposed development is a student accommodation scheme comprising approx 170 rooms, each comprising a bedspace and a bathroom, and accompanying ancillary space. The scheme also includes a basement with bedrooms and plant space; further plant space shall be located on the roof.

3. Methodology

This report uses modelling software Integrated Environmental Solutions <Virtual Environment> (IES<VE>) to determine the building's carbon dioxide (CO_2) emissions and the percentage of reductions required.

An annual simulation, taking account of the necessary building characteristics, was run to calculate carbon dioxide emissions for the following end uses: heating; hot water; cooling; fans, pumps and controls; and lighting.

Various energy-saving measures are considered in terms of technical and economic feasibility and their effect on carbon dioxide emissions. A package of energy-saving measures is proposed that meets the Part L standard, without reliance on the contribution of low/zero carbon technologies.

A preliminary assessment of renewables is undertaken based upon IES simulation data. The strategic issues relating to each technology are also considered in the context of the proposed development.

The analysis to calculate carbon dioxide savings is in line with the revised energy hierarchy as illustrated in Figure 2.

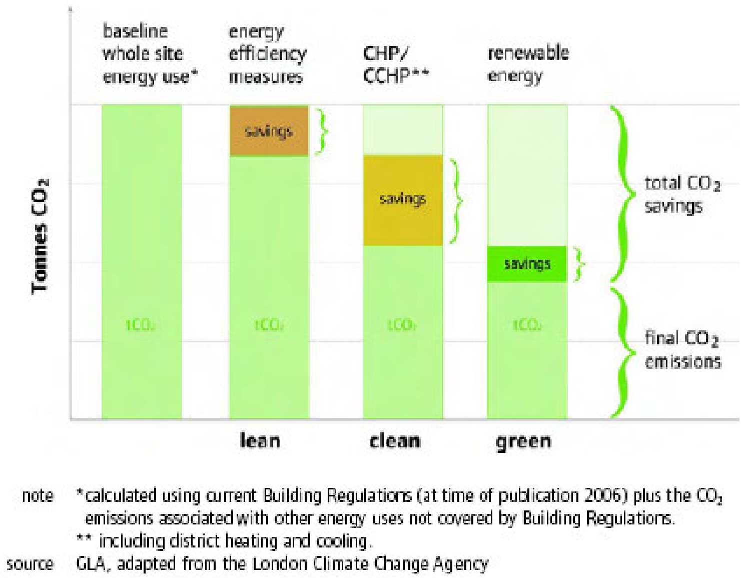

Figure 2 – The GLA hierarchy of how to calculate energy / carbon dioxide savings (Source: London Plan, Feb 2008)

Full calculations are presented in summary form in subsequent sections. Full calculations are appended.

4. Energy Demand

The proposed development would feature energy saving measures such that compliance with Part L of the Building Regulations would be achieved without reliance on the contribution of low/zero carbon technologies. This will need to be confirmed via a Part L analysis at a later date.

Proposed development

Calculations have been undertaken for the Proposed Development using IES software. Feasible improvements were included to further reduce the carbon dioxide emissions. The measures outlined below have been used in the IES calculations:

- Glazing U-value of 1.8 W/m^2K;
- Door U-value of 2 W/m^2K;
- Ground Floor U-value of 0.20 W/m^2K;
- External Walls U-value of 0.20 W/m^2K;
- Roof U-value of 0.20 W/m^2K;
- Air permeability of 5 $m^3/hr/m^2$
- Gas-fired Condensing Boilers with a seasonal efficiency of 89 %

The IES software has been used to establish the total carbon dioxide emissions of the building.

It is also proposed that all internal and external lighting is dedicated low energy fittings wherever possible.

It is proposed that the multi-residential study rooms are ventilated by natural process with a bespoke ventilation grille. This statement assumes that compliance with Part L criterion 3 can be maintained with natural ventilation – this will need to be checked in a Part L compliance study. The rooms that face South, overlooking Euston Road and that are in contact with the retained existing facade, shall have mechanical ventilation with heat recovery (MVHR) supplied to them. This is a necessary requirement because, in order to maintain suitable levels of ambient noise within the rooms additional sound-proofing measures are required. All other rooms will have a bespoke ventilation grille. A detailed ventilation strategy shall be carried out in detailed design.

5. Community Heating

The Mayor's Energy Strategy favours community heating systems because they offer:

- Potential economies of scale in respect of efficiency and therefore reduced carbon emissions; and
- Greater potential for future replacement with Low or Zero Carbon (LZC) technologies.

There is not a district heating system close to the Site. Heating and domestic hot water shall be distributed throughout the scheme via a single heat network connected to a Combined Heat and Power (CHP) engine. It has been assumed in IES calculations that a 5000 litre storage vessel is available to the DHW system. If a district heating system was established in the future, there may be scope for connection with the proposed system.

6. Combined Heat and Power

Combined heat and power (CHP) needs to be assessed in terms of feasibility. There is no economic or sustainable justification for over-sizing the CHP plant, and therefore the CHP unit size needs to be carefully matched to the demands of the development.

A CHP unit has been identified as appropriate which provides an electrical output of approximately 117 kWe and a thermal output of 210 kWt. The aim should be to size the system to maximize the run hours of the CHP to meet the baseline heat demand. As the baseline heat demand is high at approximately 150 kW, a CHP installation would be feasible.

The CHP will also provide approximately 571 MWh of electricity, which shall be used throughout the development, and if necessary sent back to the grid, via a distribution board.

Further CHP sizing needs to be carried out when more certain details are known about the development, therefore this information should be taken as draft, and indicative in nature, only.

7. Low / Zero Carbon Technologies

Preliminary Assessment

The LRT provides benchmark sizing and cost data for "renewable energy technologies suitable for London". It therefore provides information to assess the various technologies at an early design stage, with initial measurements of the impact of using each technology on the building's carbon dioxide emissions. Table 1 (below) outlines these technologies and the variations proposed in the LRT used in this assessment.

Table 1 Renewable Options

Technology	End Use Demand Met
Wind	Electricity
PV Cells - rooftop	Electricity
PV Cells - cladding	Electricity
Solar Water Heating	Annual DHW (50 %)
Biomass heating (a)	Annual Space Heating +Domestic Hot Water (33%)
Biomass heating (b)	Annual Space Heating +Domestic Hot Water (50%)
Biomass heating (c)	Annual Space Heating +Domestic Hot Water (100%)
Biomass CHP (a)	Annual Space Heating +Domestic Hot Water (33%)
Biomass CHP (b)	Annual Space Heating +Domestic Hot Water (50%)
Ground sourced heat pumps (a)	Annual Space Heating +Domestic Hot Water (50%)
Ground sourced heat pumps (b)	Annual Space Heating +Domestic Hot Water (100%)
Ground sourced heat pumps (c)	Peak Space Heating (50 %) Annual Space Heating + Domestic Hot Water (85 %)
Ground cooling (a)	Annual Cooling (50%)
Ground cooling (b)	Annual Cooling (100%)

Ground cooling is understood to refer to open-loop GSHPs which, like closed-loop GSHPs, can be arranged to deliver both heating and cooling. It would not be appropriate for residential properties without comfort cooling.

The following other "acceptable renewable energy technologies" are considered to be not typically appropriate in London:

- Fuel cells using hydrogen from renewable sources;
- Gas from anaerobic digestion;
- Geothermal;
- Ground cooling air systems;

- Micro hydro; and
- Solar air collectors.

The system size and cost benchmarks were applied to the Proposed Development and are summarised in Figure 3 (below).

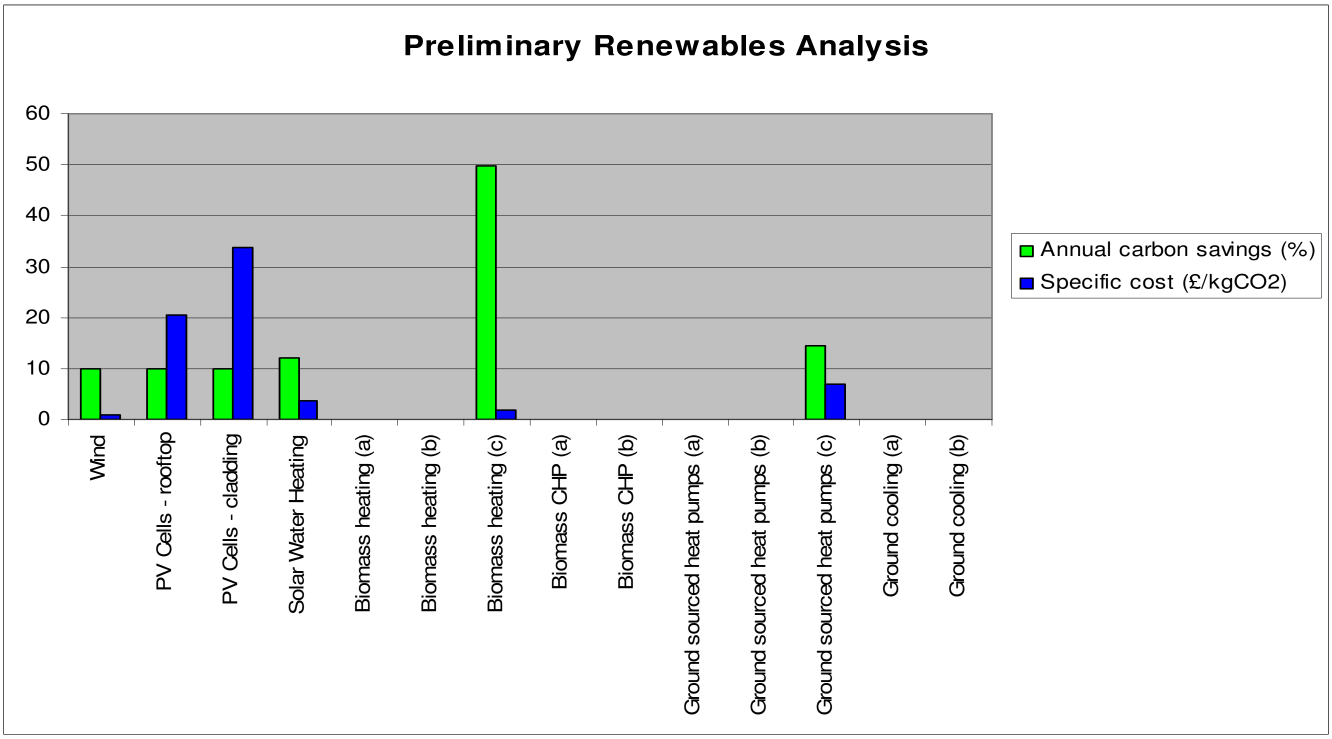

Figure 3

These are extra over costs based on benchmarks provided in the London Renewables Toolkit. Ramboll UK takes no responsibility for their accuracy. They should be viewed as indicative at best.

On the basis of this preliminary analysis, and a review of the general advantages and disadvantages of the different technologies relative to the Proposed Development, the following preferred option was short-listed:

- Solar Photovoltaics.

The following technologies were not considered to be appropriate to the Proposed Development:

- Solar Thermal Collectors; A lead CHP boiler shall provide the base hot water demand therefore limiting the benefit of Solar Thermal Collectors.

- Biomass; concerns over transport issues relating to regular deliveries of biomass; security and cost of fuel supply; on the basis of concerns over air quality issues from fuel discharge; and relatively high maintenance as requires to be shut down two or three days; and

- Biomass CHP: concerns over transport issues relating to regular deliveries of biomass; concerns over air quality issues from flue discharge; and it being an immature technology.

- Wind turbines: on the basis of poor power output within urban locations and issues surrounding associated noise and site impacts.

- Ground Source Heat Pumps; The scheme shall incorporate natural ventilation via a bespoke ventilation grille therefore limiting the need for mechanical ventilation and cooling. It could be worth examining the cost/benefits associated with this system when it is established what the realistic cooling/heating loads to certain rooms is going to be. At this stage, not enough information is provided to make an informed analysis.

Detailed Appraisal

The proposed systems are discussed in detail below;

Solar Photovoltaics

Solar Photovoltaics (PV) uses energy from light to create electricity for the running of appliances and lighting. The PV cell consists of one of the two layers of a semi conducting material, usually silicon (normally Monocrystalline, Polycrystalline and Amorphous silicon). When light shines on the cell it creates an electric field across the layers causing electricity to flow. The greater the light intensity, the greater the flow of electricity. Individually PV cells only provide a small amount of electricity, they are generally grouped together into a module for convenience and power.

PV is most suitable in urban environments because electricity is generated at the point of use, the energy loss and costs with transmission and distribution are avoided. A key advantage of PV in the urban environment is their potential to be integrated into the fabric of the building. No extra land space is required and visible aesthetics of a building can be altered – either to be unobtrusive, or to give a clear indication of 'green' credentials.
Sizes and efficiencies vary greatly within PV technology. It is still one of the most expensive forms of renewable energy however prices and efficiencies are beginning to decrease and increase respectively.

Figure 4, an example of a Solar Photovoltaic (PV) array.

For assessment of Solar Photovoltaics, a preliminary shading study was carried out as part of the Energy Strategy feasibility analysis. It was determined during the course of this study that a significant proportion of the roof is often shaded throughout the year. A limited area of roof, at the North end, may be able to accommodate Solar Photovoltaic Panels, pending a more thorough shading study being carried out. In the calculations used to produce this Energy Strategy it has been assumed that a small area of PV – $20m^2$ – has been incorporated into the development.

This area of PV would generate approximately 2,285 kWh per year, which would contribute to a reduction in CO_2 emissions of 0.2%, or, approximately 1.5 tonnes per year.

8. Conclusion

From an analysis of the Proposed Development following the detailed design in IES, the Mayor's London Plan and Camden's planning policy, the following strategy is proposed for the development.

Energy saving measures would be used to ensure that the Proposed Development exceeds the compliance requirements of Part L2A of the Building regulation. The energy efficiency measures have been identified within Section 4 of this report including;

- Improved U-values beyond Part L compliance;
- All internal, external and communal lighting to be provided through low energy lighting, wherever possible;
- Improved air permeability beyond Part L compliance;
- Energy Efficient plant including Condensing Boilers with a seasonal efficiency of 89 %.

There is not a district heating system near the site. However it is proposed the heating and hot water shall be circulated by a single network which can allow connection to a district heating system should a system be established. The heating and hot water shall be supplied by a Combined Heat and Power (CHP) engine connected to a low loss header from where heating water and domestic hot water can be supplied. The system will be backed by an energy efficient condensing boiler which shall supply the heating and hot water demand peaks.

A number of options for renewable technologies have been studied in detail, and the following measures proposed:

- A 20m^2 Solar Photovoltaics array located on the north end of the proposed development's roof.

The passive technologies and energy saving measures above lead to an annual emissions rate of 737 tCO_2. The addition of a CHP unit provides an annual reduction of 147 tCO_2 which equates to a reduction of 20 % of the total site CO_2 emissions. Furthermore the Solar PV

Panels added will contribute a saving of 0.2%, which equates to 1.5 tonnes of CO_2. The development is therefore compliant with the Mayor's London Plan and Camden's UDP.

Model	Gas Demand (MWh)				Electricity Demand (MWh)								Carbon Dioxide Emissions (t)	Emissions reduction compared to previous stage (%)
	Space heating	Hot water	Other	Total	Space heating	Hot water (Bentley House pumps)	Cooling	Fans, pumps and controls	Lighting	Other	Total Electricity Demand	Elec. On-Site Generation	Total	
Design Stage 1 - Energy-saving	321	1,485	0	1,806	0	72	7	3	284	550	915	0	737	
Design Stage 3 - CHP	110	464	2,143	2,716	0	72	7	3	284	550	915	-571	589.79	20.00
Design Stage 4 - Renewables	110	464	2,143	2,716	0	72	7	3	284	550	915	-573	588.49	0.2
Proposed Development	110	464	2,143	2,716	0	72	7	3	284	550	915	-573	588	0.0

Figure 5:

Bentley House energy use by type, and CO_2 emissions calculations. Below IES images;